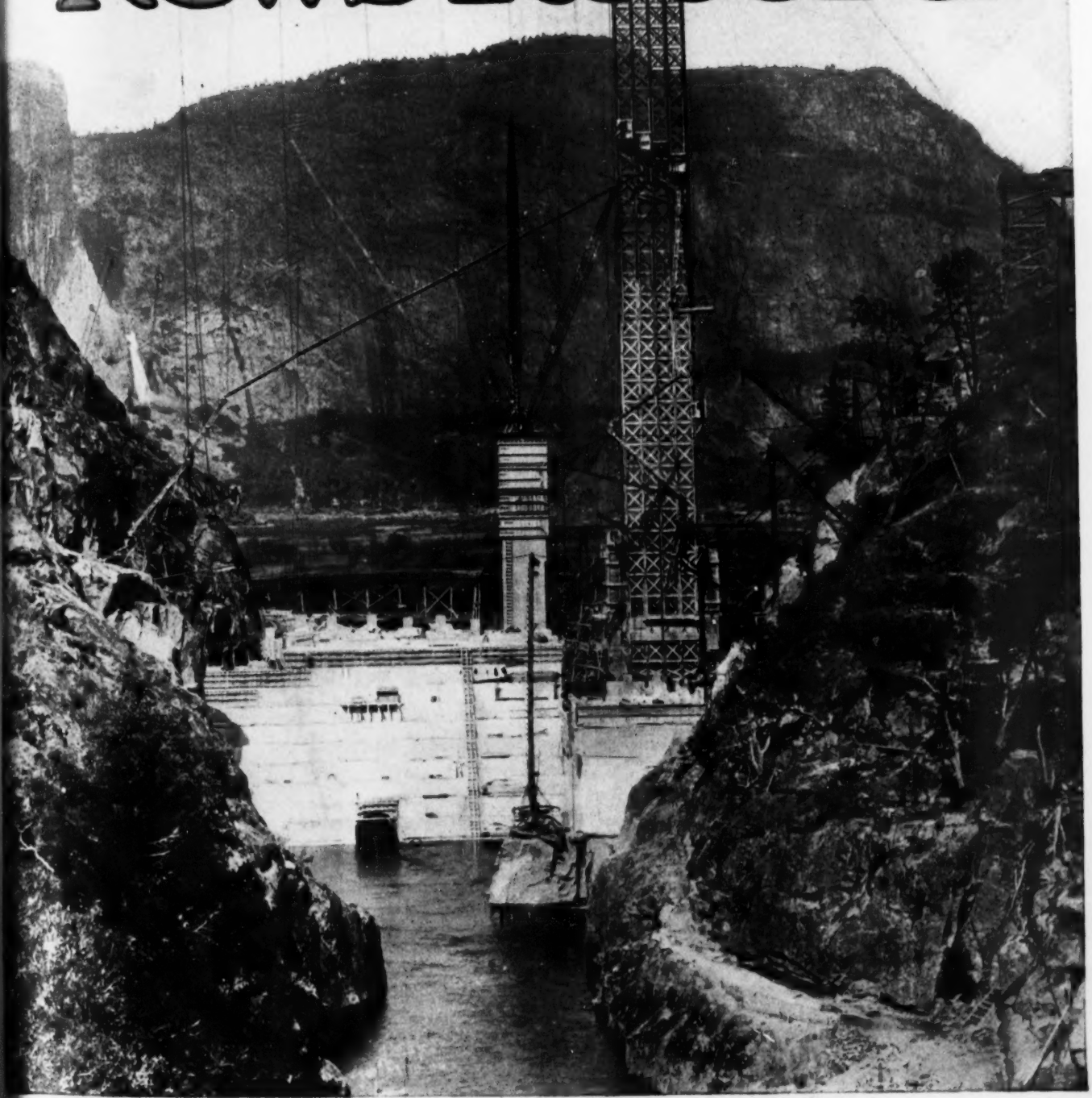
JUN 12 1922

Devoted to Civil Engineering and Contracting. McGraw-Hill Company, Inc.

June 8, 1922

Engineering News-Record

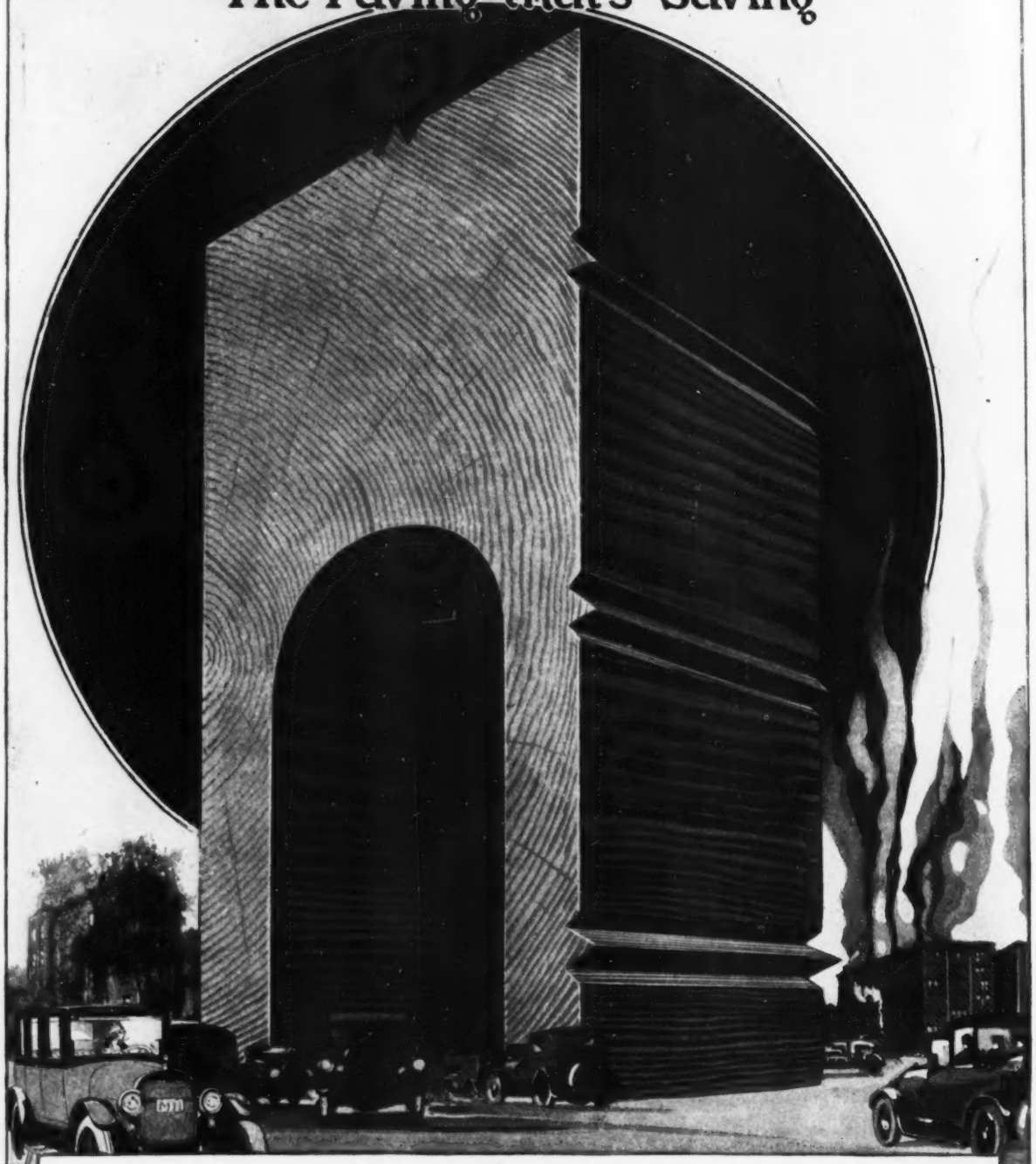


Looking upstream toward Hetch Hetchy Dam for San Francisco's water supply. Tower is 350 ft. high

In this issue: **Tests and Application of the Backwater Suppressor — A 350-ft. Steel Arch Encased in Gunite — Holding the Mississippi Levees at Oldtown, Ark.**

KREOLITE KOUNTERSUNK - LUG - BLOCKS

"The Paving-that's Saving"



Enter the portals of paving permanence
through the medium of
Kreolite Kountersunk Lug Wood Blocks

Write for detailed specifications and information
THE JENNISON-WRIGHT COMPANY
79 Kreolite Building, Toledo, Ohio

A Consolidation of Engineering News and Engineering Record — McGraw-Hill Company, Inc.—JAMES H. McGRAW, President

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN, Editor

Volume 88 — NEW YORK, JUNE 8, 1922 — Number 23

Plain Tales from the Valley

SUPPLEMENTING the general account of the fight against the Mississippi flood, presented by our western editor in the issues of May 18 and May 25, we offer, in this issue and the next, two close-up views of unusual interest. L. R. Parmelee, who contributes the first of these, relates a stirring tale of how one community organized overnight to cope with a threatened levee break. A. L. Dabney, whose story will appear next week, tells of a struggle with the "devil's hole," an extraordinary maelstrom that gnawed and gnawed incessantly at a crumbling levee despite every expedient and every effort to subdue it. Engineers will know how to appreciate these stories, so well told by their professional brethren who have been serving in the thick of things.

Politics and the St. Lawrence

WHILE a different complexion is put on the St. Lawrence waterway situation by the statement of the Canadian premier that his country is not now prepared to enter into a treaty for the joint development of the river, the jubilation of the waterway's opponents over what they seem to consider the quietus of the scheme is somewhat hasty. Politics is not an unknown science, even in Canada, and there, as in this country, there are sectional "blocs" which have to be placated. Premier King's present stand means only that in Canada, too, there is division about the St. Lawrence and that this is not a propitious time to force the issue. It ought not, however, interfere with the economic investigation of the project which should be made and it will serve to convince a number of people of the untruth of the insinuation that the scheme is a Canadian effort to make the United States pay for a Canadian development.

"Competition" that Maintains Prices

BEWILDERED, we turn from a reading of Judge Gary's testimony before the Lockwood Committee in New York. The Steel Corporation, it appears, working at half capacity makes 45 per cent of the steel output of the country. Thanks to great volume and superior efficiency, it could sell its product for at least $3 per ton less than it does and still make money. If it should double its output and cut its price it might play havoc with its competitors; might, in fact, put them out of business. But, Judge Gary explains, that would never do, for then it would run the risk of dissolution by governmental action. Now, unified large-scale production is justified in economics on the ground of lower costs, and competition is designed to insure the lowest price warranted by the demand. But in our feeble efforts to guard against the possibility of an oppressive monopoly we follow a policy that withholds from the consumer the benefits of lower costs and taxes him to support a "dummy" competition of which the net result is to maintain prices to the considerable profit of the Steel Corporation. If we must interfere with the operation of economic processes is it not possible to devise a plan that will avert the danger we fear without denying to ourselves the benefits of large volume production and efficient management? Or is this the price we must pay for immunity from a possible abuse of industrial power?

A Different Power House

HYDRO-ELECTRIC power-house layout is naturally changing along with prime-mover design. The most obvious developments have been in the draft tube though there are suggestions as to siphonic discharge, accompanying inverted turbines, which make some difference in the power-house arrangement. A decided variation, with many points to commend it, is the layout adopted for the Mitchell plant on the Coosa River described on another page. Mr. Thurlow's ingenious adaptation of the hydraulic jump to avoid backwater has resulted in a distinctly different kind of power house in which each wheel has a setting separate from the others, in effect, a mass of concrete extending upstream from the dam. This permits an economy of machine space and of power-house structure, the latter being only a low removable roof over which travel the control cranes. The resulting structure is economical and compact, an admirable solution of the low head plant.

The Ultimate Producer

THE news from Europe indicates that Germany is making a strenuous effort to set her financial house sufficiently in order to justify a foreign loan. She proposes, for example, to stop printing paper money, to prevent the exportation of her own capital and to impose upon herself a régime of rigid economy, subject to supervision by her creditors. The loan, however, is not yet assured, nor will it be assured until it has won the confidence of the man in the street; for after all, it is the individual investor who must be satisfied as to Germany's ability and willingness to pay before he will lend her his savings. Again we are reminded that when all is said and done the economic world is beyond the control of statesmen and bankers. They may plan the engine and set it up—they may even guide it and manage it; but the motive power flows wholly from the hopes and the fears, the understanding and the energy, the distrust and the confidence of the plain people.

Estimating Brickwork Costs

SUCCESSFUL estimating of a construction job must be more than a rough approximation of the general items of expense. Nevertheless there is too great a tendency in preparing estimates to disregard minute details and to cover them by flat percentage additions. On the other hand, extraordinary refinements in making a bid are unnecessary. A proper balance, it ap-

pears, would be that system which makes, in effect, a self-sustaining contract out of each of the separate processes found on one construction job. Personal experience and tireless investigation of printed data only can adduce the information upon which to base safe and sound estimates. It is not often that a man makes an analysis of his own work except as he may benefit personally. When such analyses are made and published they are of inestimable value to the profession. This Mr. Dingman, whose treatise on estimating the cost of brickwork appears in this issue, has done. It is one of those articles which contractors will clip and display prominently when bids are being prepared.

A Novel Bridge Design

MOST exceptional in design is the 350-ft. arch of the Oregon City bridge described elsewhere in this issue. Concrete encased self-supporting steel arches for reinforcement of bridges are not new, the most recent example being the Springfield bridge described in these pages a few months ago, but gunite coating acting in effect as a heavy long-lived paint is unique for so large a structure. As Mr. McCullough points out in the article the problem, both as to topography and clearance and as to needed protection, was unusual and the design was adopted only after careful weighing of the various alternatives. It is apparent, however, that the suspected danger from the corrosive action of gases prevalent in the neighborhood was the governing factor which led to the substitution of gunite for paint, at what must have been a considerable excess cost. Whether there is an additional gain in appearance which might also justify the expedient must remain a question of individual preference or, at least, cannot well be decided until the bridge is completed.

To Chambers of Commerce

PRACTICALLY all of modern business is housed in fireproof office buildings. Erected during the last quarter century at a cost of untold millions of dollars, these structures are commonly believed to afford the contained business offices complete protection against destruction by fire. Unfortunately for this belief, the armor of the fireproof building is quite vulnerable. The fact has been known, though not very concretely realized, for a number of years, but the Burlington building fire of three months ago demonstrated it so plainly that the problem now is before us in definite terms.

It is a problem jointly of the business man and the fire-protection engineer. The latter is fully awake to the situation but the business man, who is not as closely in touch with the facts of the situation, still needs to be stirred to action. This work devolves on his own business organizations, the chambers of commerce; it is up to them to recognize the existence of the problem and bring it up for thorough discussion in business circles.

Virtually every office building is powerless to resist the fierce attack when fire in a neighboring building or group of buildings develops intense heat. Under such attack, windows will break or melt, and many stories simultaneously will be entered by fire and their contents destroyed utterly. A large factor of the result, moreover, is the heat produced by the contents of the building attacked; the current impression that there is little to burn or produce heat in a modern office is sadly in error. An office building surrounded by other fireproof buildings is virtually free from this exposure danger. But few are so fortunately placed. And, as the combustible building, and perhaps even worse, the building with highly combustible occupancy, are still common in even our best business districts, it is evident that many office buildings will continue to be subject to the exposure fire danger for years.

Lest the preceding be construed as making it appear that the fireproof building gives no protection whatever, it may be well to set down what it does and what it does not do in the way of protection to its contents. The modern office building is incombustible and indestructible; it furnishes no fuel to sustain a fire, except what its contents provide, and the most intense fire in one part of it will not wreck it and bring down the rest of the building. It affords absolute safety to human life; provision for egress and the protection of stairs and elevators have been worked out in brilliantly successful manner. Each floor is completely isolated from other floors with respect to fire transmission, so that one floor might burn out completely and not do injury on the floors above and below; indeed a fire might start anywhere in the building and everything outside of a relatively small compartment would be secure. The internal fire danger as a whole has been disposed of. The outside fire danger largely remains. Against mild exposure the building is fairly secure, by virtue of its incombustible walls. It is secure even against moderately severe exposure on those sides where its windows are glazed with wire glass (which is not generally the case with street fronts). But even with wire glass it is likely to succumb to a very severe exposure, and fire will then enter the window openings and will start intense fires in the papers and other combustibles of the contained offices, in which event the building is no better than a good furnace.

To the preceding we should add that the widespread custom of arranging full open floors without fire-wall subdivision increases the destruction when fire once enters. Interior fireproof partitions can be built, and many buildings have them; such partitions insure the safety of that portion of the building away from the outside exposure. Far greater danger attaches to the open floor construction. But even where there are interior partitions to stop the progress of a fire when one side of the building is attacked, the destruction of those offices directly adjoining the exposed side is sufficiently disturbing a contingency to warrant anxious care in providing safeguards.

More than the direct money values, the appraisable risk, it is necessary to consider the indirect values at risk. These lie in the business importance of office contents as part of a going machine, and the extensive disorganization that may follow the destruction of an office. Activities of great scope are likely to be paralyzed, or at least thrown out of gear for a time. Business is becoming increasingly interrelated, and year by year the individual office is likely to become more intimately interwoven with manifold business and industrial activities. It is therefore the concern of the entire business community, and ultimately of the entire country, to seek to attain more complete protection of the office building.

The risk of outside fire attack to which any one building is exposed is about as small as the chance of a dwelling being struck by lightning. Yet we insure against that and we put up lightning rods.

Several means are available to protect the office building against outside exposure. Window protection is the great difficulty to be dealt with. A minor one is the subdivision of floors by fireproof partitions. If windows can be protected perfectly, the whole problem is solved, provided those who own and occupy office buildings are willing to incur the necessary expense for this protection. If only imperfect protection of windows can be realized, the interior separation will be a further safeguard of great importance.

Wire glass is the first safeguard and the most necessary one; yet at the same time it is the least complete. It will not protect fully, but wire glass in metal frames represents a long step toward full protection against even maximum exposure, and is all that is needful against mild exposure. Automatic rolling shutters are a much more powerful resource, and in the opinion of some give promise of being the most ultimate complete protection. Water sprays arranged so as to play over the outside of the glass surface are reported to be highly effective, and inside sprinklers have shown considerable merit, though sufficient water supply is not easily provided and failure of supply means failure of the protection.

None of these protective means, however, are of any use until they are applied. They will not be applied unless business men and building owners quite generally appreciate the need for protection. To bring about this appreciation is no concern of the insurance companies, for the major loss in the destruction of office building contents is the uninsured loss which falls on the businesses involved and on the interests depending upon them.

The real interest in office building protection centers in organized business, and chiefly in those association of business men whose function it is to deal with the needs and problems of business. Chambers of commerce, in other words, carry the main burden of responsibility for making known the true situation with respect to the exposure danger of office buildings and for bringing about a study of the magnitude of danger and of protective means. If chambers of commerce will take care of the psychological part, there is little doubt that the fire protection fraternity will be found willing and eager to deal with the physical part of the problem.

Rivet Service and Tests

ELABORATE tests of rivet steel and rivets just reported by the Joint Committee on Sulphur and Phosphorus in Steel invite the structural engineer's attention for the information they may give on rivet quality. The primary purpose of the tests was metallurgical: to determine whether or not sulphur has a harmful influence on soft steel. However, as the committee chose for the work a series of steels approximating commercial rivet steel (except in point of sulphur), and as it used some of the samples for making rivets and subjected these to bending, heading-up and flattening treatment, the results afford extensive data on the mechanical properties of rivet bars and rivets. These data bring to the front the knotty question of how to predict rivet service by tests, a question never satisfactorily answered, we believe.

At first glance the newly reported test results create a confusing impression. The committee presents numerous plottings of the results of various kinds of test, but for unknown reasons it defers interpretations and analysis, without which a set of tables and diagrams is apt to contain many traps for the unwary. Further, as the plottings are all on a sulphur base, it is not easy to perceive the influence of other variables. But the tables of chemical composition show decided variations in carbon and manganese, and a study of the diagrams suggests that many of the ups and downs in mechanical properties match the manganese and carbon rather than the sulphur variations. From one point of view it may be said, therefore, that the committee investigated a rivet-steel range rather than a sulphur-content range.

The report covers a diversified list of mechanical properties, including not only the customary tensile strength, yield point, elongation and reduction of area, but also hardness, notched-bar impact, plain impact shear, cold bending, head flattening, and shearing strength (of riveted joints). Generally the values of all of them are seen to hold up well throughout the variation of conditions, except that yield-point strength is lowered by annealing and raised by quenching, while notched-bar impact is further affected unfavorably by increasing impurities. Forgeability, tested by the making of rivets, and cold-bend and cold-forging properties show no pronounced effect, though some of the high-sulphur bars when quenched—an abnormal treatment—could not be bent over flat. It should be remarked also that elongation varied much more than reduction of area, being more seriously affected by high sulphur, for example.

From the practical engineer's standpoint the first point to be settled in connection with such a series of tests is which of the samples are to be classed as acceptable rivet steels, and which, if any, ought to be rejected. Is tensile yield-point the main criterion? Can a certain figure be set as the minimum permissible elongation for rivet service? Does the bend test or the Charpy impact test mean anything for rivet use, since rivets are not subjected to any extreme bending or to notched-bar-impact conditions? If the practical requirements for good rivets are suitability for tight driving, high shearing strength, and ductility (both hot and cold) enough to insure against cracking and heads flying off, what is the simplest way of checking up on these requirements by advance test?

There are excellent reasons why such questions should be answered, if possible, in connection with the present test series. First, if any conclusions are to be drawn from the tests with respect to the influence of sulphur on rivet steel, it would seem to be necessary to know what constitutes good rivet steel, from the user's point of view. Second, if good rivet performance is adequately defined by certain ones of the tests, the present series of tests offers the best possible opportunity for shelving the unnecessary or purely fanciful tests.

The questions thus presented address themselves to the engineer rather than the metallurgist, but they are equally important to the latter, for only after they are answered in a practical way will the metallurgical findings from the tests have effective meaning. Incidentally, the answers will tend to improve present practice in specifications for rivet steel, whose variations indicate that they were developed from a knowledge of what properties ordinary commercial steel possesses rather than from definite conviction as to the requirements of rivet service.

Large Steel Arch Bridge Ribs Encased in Gunite

Oregon Highway Bridge Has Central Span of 350 Ft. Made Up of Structural Steel With Thin Concrete Covering—Comparison of Alternate Designs Considered

By C. B. McCullough
Bridge Engineer, Oregon State Highway Commission, Salem, Oregon

A STEEL arch, 360 ft. between pier centers, 350 ft. between skewbacks, and encased in concrete applied with a cement gun is now being built by the Oregon State Highway Commission, as the main span of a concrete and steel bridge across the Willamette River at Oregon City, Ore. This unique type of bridge structure was decided upon only after an extensive comparative investigation into different types for the crossing. The considerations which governed the objection of the other types and the selection of this one, and the details of the bridge now being built are the subject of this article. The methods of erection, which also required some comparative study, will be discussed in a later article.

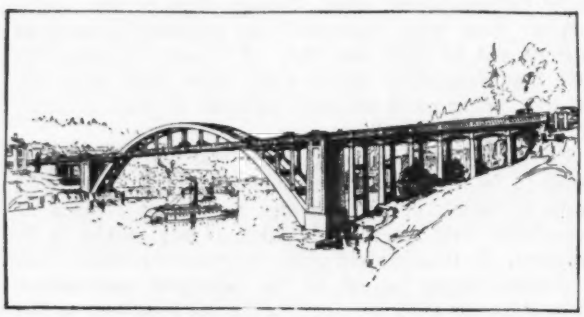


FIG. 1. SKETCH OF BRIDGE AT OREGON CITY

The bridge, 850 ft. in over-all length, is to carry the main Pacific Highway traffic over the Willamette River, and is located between the cities of West Linn and Oregon City. The site selected for this structure takes advantage of the natural topography, being the narrowest channel point within the limits of variation possible with the highway location; in fact, this point is one of the narrowest necks in the river for a very considerable distance either way. The Willamette at the bridge site flows in a well defined and very deep channel bounded by high cliffs of basaltic formation, the maximum stream depth at mean low water being over 100 ft.

The bridge crossing is, unfortunately, located in the immediate vicinity of certain large industrial plants employing sulphurous acid as a reagent, with the result that, at times, the atmosphere is more or less densely charged with sulphurous anhydride (SO_2). Corrosive action in this atmosphere appears to be considerably stimulated, and it was thought that an unprotected steel structure might impose an undue burden of maintenance upon the state. The city of Oregon City is located but 15 miles from Portland and is one of the biggest industrial and manufacturing towns in the state. The bridge, which will be a link in a highway surfaced on either side with heavy traffic pavement, will, therefore, be subjected to exceptionally heavy truck traffic as well as a large volume of pleasure traffic and pedestrian travel to and from the large paper mills that lie on the West Linn side. The waterway is navigable and fairly busy as regards river traffic, requiring a horizontal and vertical clearance not less than that shown in Fig. 1.

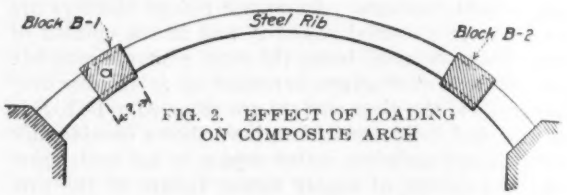


FIG. 2. EFFECT OF LOADING ON COMPOSITE ARCH

In order to meet the conditions above outlined and, at the same time, take advantage of the narrow and rock bound character of the stream crossing, preliminary studies were made for seven distinct types of construction and covering a period of nearly two years, with the following results:

Type A. Suspension Span—Abandoned because of the cost of making such a structure rigid enough to carry the heavy truck traffic without injury to the roadway pavement, and also because no feasible method of protecting the metal against corrosive influences presented itself.

Type B. Cantilever Span—Type C. Simple Truss Span and Type D. Spandrel Braced Framed Arch, were each tried successively, and were abandoned owing to the difficulty encountered in securing a suitable type of encasement or protective covering at a reasonable cost.

Type E. Reinforced-Concrete Arch—This type was abandoned owing to the great cost of supporting the centering for the extremely heavy and massive concrete rib. The great depth of the water coupled with the fact that the channel must be kept open at all times for navigation rendered the use of falsework out of the question. In this connection investigation was made of the use of suspended centering which was also discarded in favor of the more practical and positive method outlined under Type G below.

Type F. Steel Arch Rib With Poured Concrete Encasement—This type was considered a long time and complete details were at one time worked out for the same. Some very interesting problems were encountered a very brief mention of which may be in order.

The first scheme for this type employed an encasement designed to take a portion of the rib stress, in other words, the steel rib was simply utilized for supporting the formwork for a nearly solid concrete rib. The rib sections were to be poured block by block loading each rib simultaneously and symmetrically. It is readily seen that, as this load is placed, stresses of ever increasing magnitude are set up in the rib steel. When the rib itself is swung the stress at any point a has a certain value S_1 which may be easily determined. (See Fig. 2). Having the rib swung, the first voussoir or

rib block *B*-1 may now be poured. As soon as concrete pouring commences the rib starts to deflect under the additional dead-load so that at the end of this pour the stress in the steel is at some new increased value S_s. The concrete in the meantime is in a semi-plastic condition so that, if precaution is taken to thoroughly spade and "rod" the mass we may reasonable assume that at the end of the pour the stress in steel $= S_s$ and the stress in concrete $= 0$.

The addition of a second block *B*-2 anywhere along the rib now operates to increase the stress in the steel at point *a* to a new value S_s, the rib length L_s is therefore shortened and a stress S_c, where

$$S_c = \frac{(S_s - S_s)\,(E_c)}{E_s},$$

is at once set up in the concrete. Stresses of this kind, imposed upon *green* concrete undoubtedly shatter and break the initial set for which reason it would seem essential that each block be poured and allowed to set before any additional load was placed upon the rib. This scheme required so much time that it was abandoned in favor of a very thin, poured encasement, designed merely as a *protective coating* and not in any way as augmenting the stress carrying capacity of the steel rib.

This thin encasement presented a very difficult construction problem as regards pouring. It was felt that an encasement such as this would undoubtedly give the public a sense of security and that this must not be *false* security, in other words there must be no porous pockets with the consequent danger of the steel rusting underneath the concrete. An encasement, designed to insure the degree of density and positive protection considered essential, proved very costly and also imposed a very severe dead-load on the rib.

Before finally abandoning this type altogether, experiments were made looking toward the adoption of a *light-weight* aggregate. At one time this seemed to be the answer, however Type G described below had so much to recommend it, both in cost and serviceability that it was chosen as the final solution.

Type G—Steel Rib Arch Gunite Encasement—This design, which was the one finally adopted, contemplates the construction of a main channel span 360 ft. center to center of piers, flanked on either end by approaches of the reinforced column and girder type (see Fig. 1). At the Oregon City end is a retaining wall and fill, the wall being of the cellular type of comparatively thin concrete sections, heavily reinforced. The span carries a roadway 19 ft. clear width and two 4 ft. 6-in. sidewalks. It is designed as a half-through span to provide the required vertical and lateral clearances for navigation. The following loadings were used in the design:

Concentrated loading consisting of two trucks abreast of the following dimensions and weights:

1. Total weight	40,000 lb.
2. Weight concentrated on rear axle	28,000 lb.
3. Distance, c. to c. axles	10 ft.
4. Distance, c. to c. wheels	6 ft.
5. Length of roadway occupied	24 ft.

That portion of the roadway not occupied by the truck loading as above, was assumed as loaded with a uniform load of 70 lb. per square foot. The sidewalks

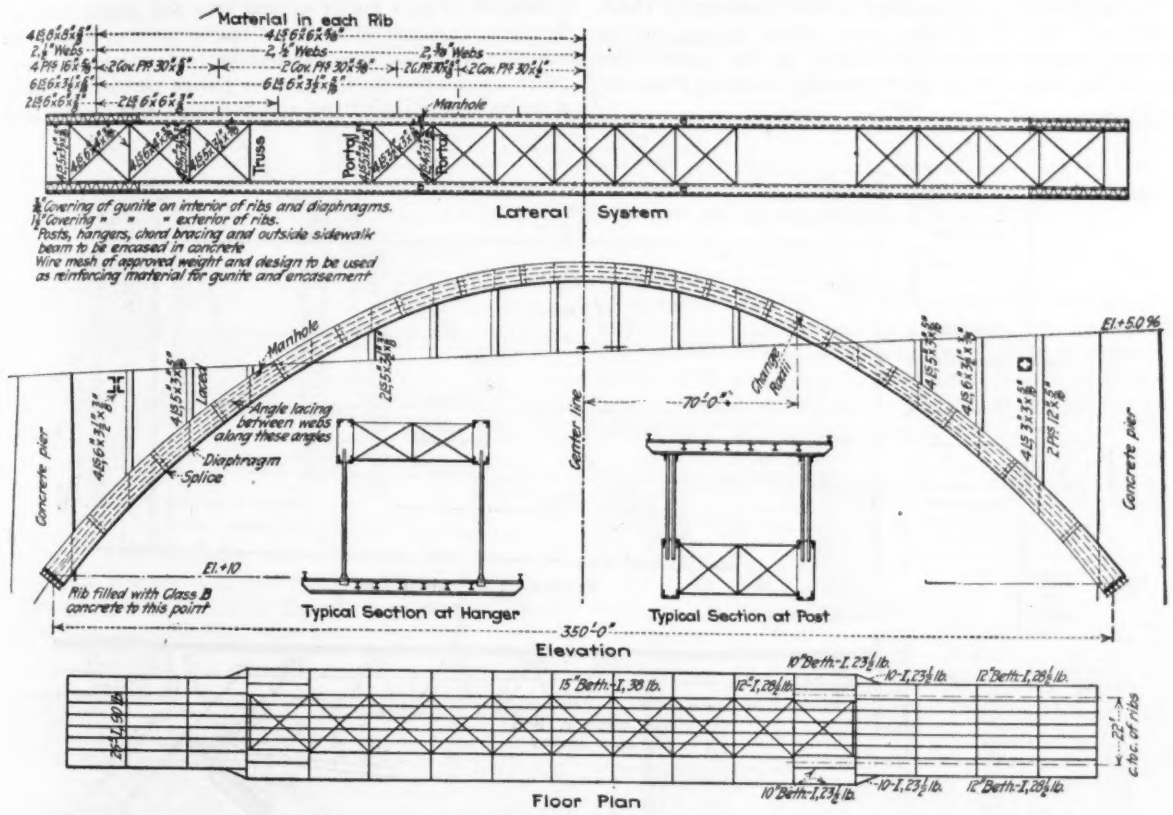


FIG. 3. STRUCTURAL STEEL MAKE-UP OF MAIN ARCH

were loaded with a uniform load of 60 lb. per square foot.

The stress analysis was made after the method of variable "rotation loads" or "elastic weights" described by the writer in *Engineering News-Record*, April 1, 1920, p. 675. Arch reaction and stress influence diagrams were plotted and the above loading placed in such manner as to produce the maximum rib stresses.

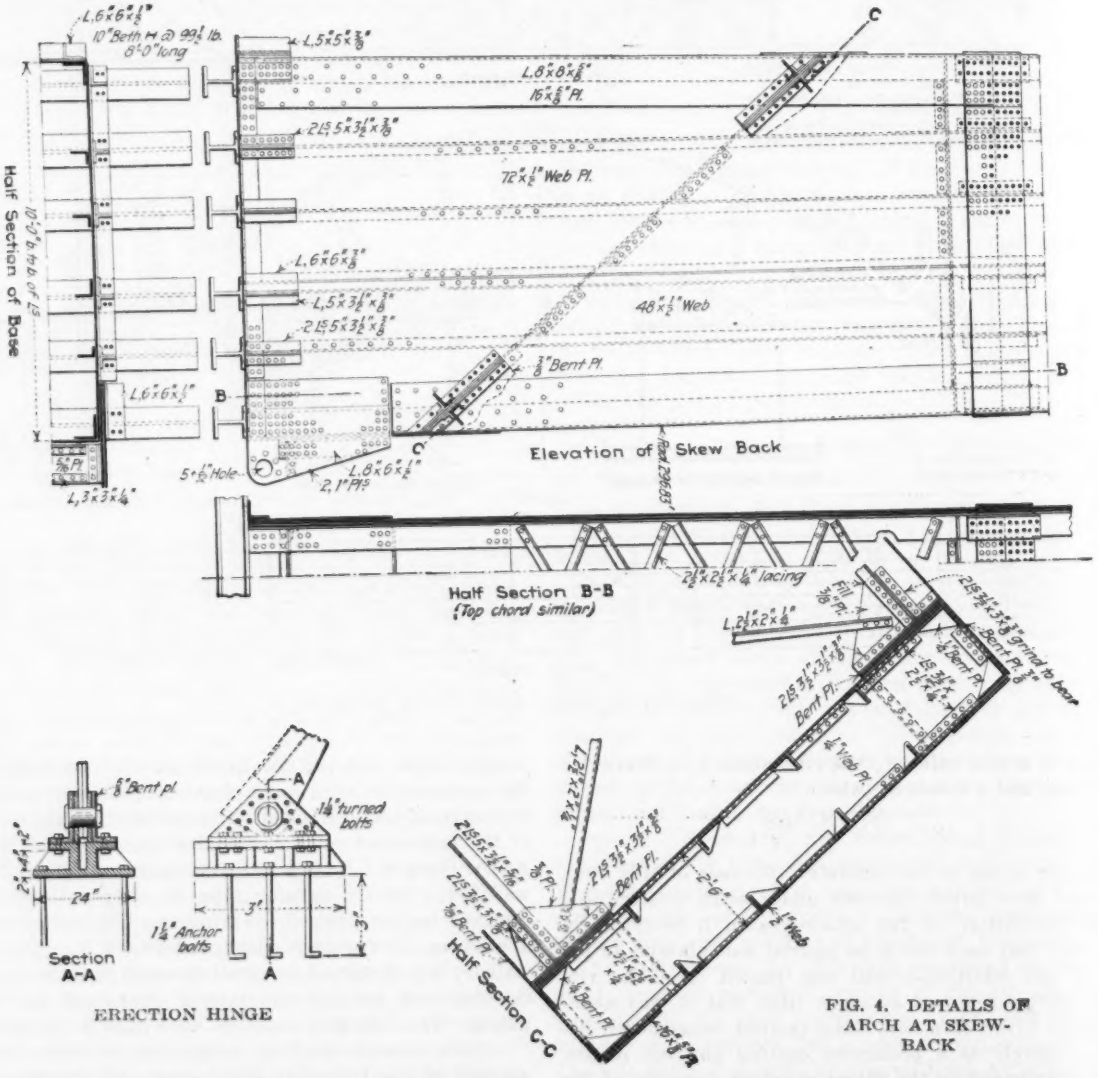
The main arch rib is of structural steel designed with particular attention to the requirements enumerated below:

1. To produce a rectangular section, thoroughly rigid, and with top and bottom cover plates to support the gunite encasement, which section at the same time would be accessible for field and shop riveting from the inside.

the temporary construction hinge provided in the design. A similar arrangement will be used at the crown.

As soon as the ribs are swung and the lateral system in place, 30 ft. of the rib at each skewback will be completely encased and filled with Class B concrete, thus rigidly fixing the ends. The crown hinge will next be replaced by a heavy splice connection designed to transmit the maximum thrust, moment and shear at the crown. The rib then becomes a fixed or hingeless arch under all additional dead and live loadings.

The main arch rib consists of a box girder section composed of four flange angles, two web plates and six to eight longitudinal stiffener angles riveted inside the rib. For the solid concrete section (extending out about 30 ft. from the skewback) four flange plates are added and the section laced top and bottom. For the balance



ERECTION HINGE

FIG. 4. DETAILS OF ARCH AT SKEWBACK

2. To so detail the section that all diaphragm angles and stiffeners would be inside leaving a plane rectangular surface for the application of the wire mesh and gunite encasement.

3. To allow for inspection of the interior of the rib both during and after construction.

The steel ribs are to be erected first, and swung as a three-hinged arch. Fig. 4 illustrates the nature of

of the rib top and bottom cover plates are used in order to carry the encasement of gunite. Diaphragm plates are used to stiffen the rib as shown in Fig. 4, these being apertured with manholes to aid in construction and also to permit maintenance inspection from time to time. Manholes will also be left in the top cover plate at convenient points to permit access to the interior of the rib for future inspection of the condition of the

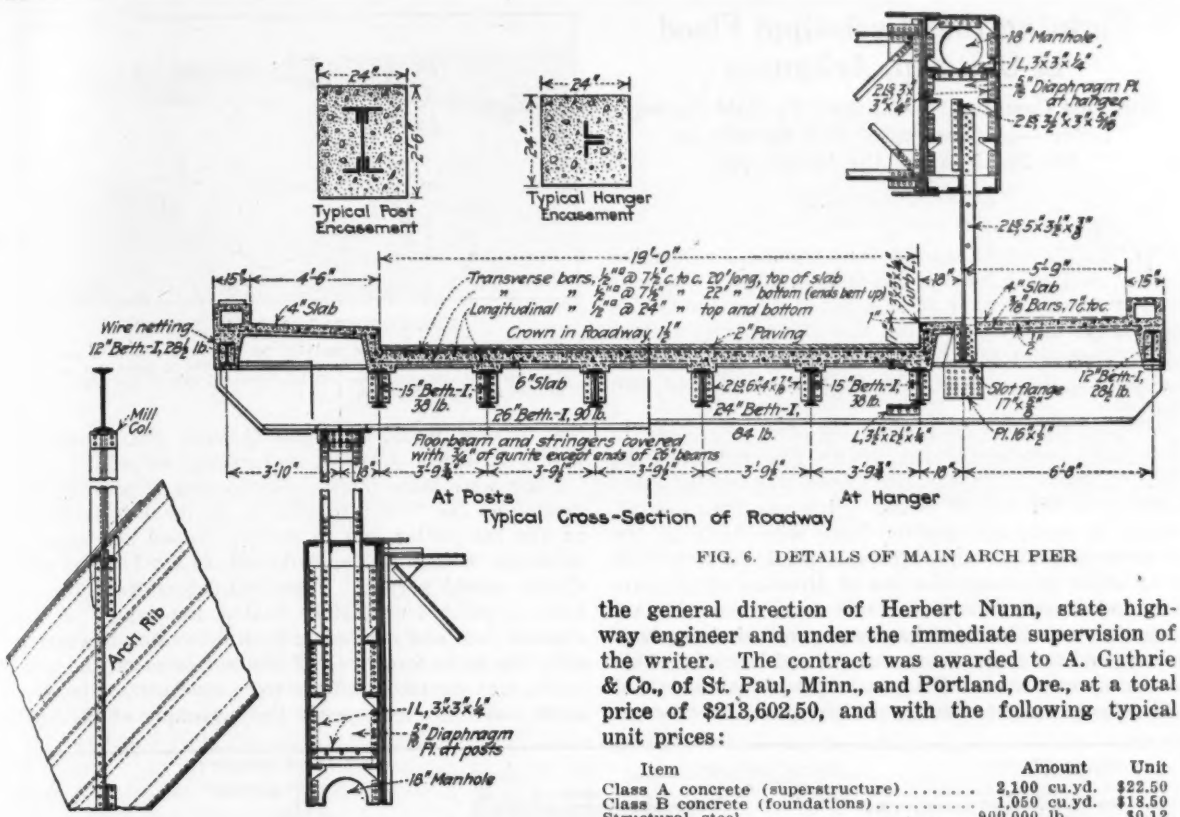


FIG. 6. DETAILS OF MAIN ARCH PIER

gunite. These manholes will, of course, be covered by removable hatches of non-corrosive material.

The general make up of the rib is shown in Fig. 3, and it has the following make up:

RIB

4	flange angles	8 x 8 x	⅞	in.
2	web plates	⅜ x 120		in. (approx.)
4	flange plates	16 x	⅞	in.
6	longitudinal stiffener angles	6 x 3½ x	⅞	in.
2	longitudinal stiffeners	6 x 6 x	½	in.

CROWN

4	flange angles	6 x 6 x	⅞ in.
2	cover plates	30 x	½ in.
2	web plates	72 x	½ in.
6	longitudinal stiffener angles	6 x 3 x	⅜ in.

The inside of the section is to be covered with a ¾-in. gunite encasement, the exterior is to be covered with wire mesh and given an encasement of gunite 1½ in. in depth, finished with a carpet float.

The hangers and columns as well as all portal and lateral frames are to be completely encased in a solid poured concrete encasement. The structural frame used for the portal is to be encased in a curved and panelled portal beam. The entire lateral system is of similar construction. The floor system is of structural members encased in gunite as shown in Fig. 5.

Fig. 6 illustrates the general design of the arch piers. Under each pier provision is made for comfort stations and observation balconys which are entered from the floor elevation by stairways leading from the upper balcony. The fixtures for these rooms will be furnished and installed by the cities of West Linn and Oregon City.

The design and construction of this bridge is under the general direction of Herbert Nunn, state highway engineer and under the immediate supervision of the writer. The contract was awarded to A. Guthrie & Co., of St. Paul, Minn., and Portland, Ore., at a total price of $213,602.50, and with the following typical unit prices:

Item	Amount	Unit
Class A concrete (superstructure)	2,100 cu.yd.	$22.50
Class B concrete (foundations)	1,050 cu.yd.	$18.50
Structural steel	900,000 lb.	$0.12
Metal reinforcement	270,000 lb.	0.055
¾-in. gunite	23,000 sq.ft.	0.17
1½-in. gunite	22,000 sq.ft.	0.29

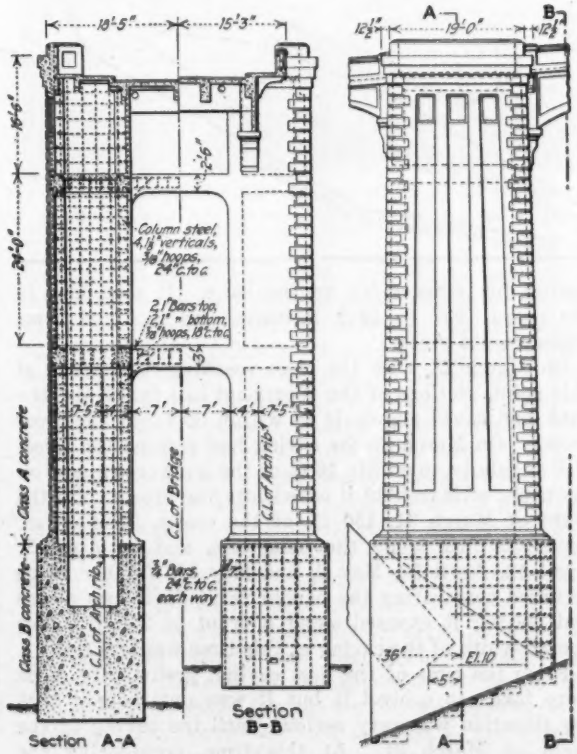


FIG. 6. DETAILS OF MAIN ARCH PIER

Fighting the Mississippi Flood at Oldtown, Arkansas

How One Community Managed To Hold Caving Levee — A Close-up of One Episode in the Battle Along the Mississippi

By L. R. Parmelee
Civil Engineer, Helena, Ark.

OLDTOWN, Ark., an old boat landing, is 20 miles below Helena, on the Mississippi River. One mile farther down the river at milepost 21-22 of the Cotton Belt Levee District occurred one of the most serious of the highwater fights that took place during March, April, and May, 1922. The Oldtown fight was successful.

Milepost 21-22 is on the outside of a great turn in the river known as Oldtown Bend. The channel of the river, in the bend proper, has moved westwardly about 2,000 ft. in the last 25 years. High velocities prevail. About 16 years ago abattis dikes were built by the government several miles upstream from milepost 21-22 in an effort to change the line of direction of the current and thereby break its force away from the Arkansas shore. The bend has been revetted throughout mile 21 and for some distance above and below it. This revetment consists of the usual willow mat weighted with stone, accompanied by either stone or concrete paving for some width up the bank. It was done in the years 1907 to 1910 inclusive and has had some replacements since.

On March 23, with the river reaching flood stage at this point, sections of the revetment had failed and the bank had caved angularly to within 39 ft. of the levee crown. On March 29 the caving had entered the levee, still angularly, to within 16 ft. of the levee crown, and on the night of March 29 it caved into the crown. On the night of March 31, 150 ft. of the crown itself caved, leaving a face along the banquette, and on April 2, April 12, April 22, May 5, and May 13, further caves occurred penetrating the banquette 20 ft. in two places and leaving it exposed along a front of 250 ft. The overall width of the caving at this time was 500 feet.

From the time of the first caving, preliminary steps were taken to control it but it was not thought that the situation was very serious until the caving of the night of March 31. At this time, considering the intervals between the previous caving and the wide front suddenly exposed, it was reasonable to presume that caving would continue through the banquette, within 72 hours unless it was greatly retarded.

FIG. 2. BREAK IN MAIN LEVEE

The men on the left are walking on the first sub-levee which was thrown around the break just in time to hold the river. The upright sticks in the left background are in the core-wall of the second sub-levee.

Plans were made immediately to stop, if possible, the erosion on the front; to build a sub-levee of sandbags on the banquette; and to start a second sub-levee of sandbags, with a timber core-wall, as far back as conditions would permit. These sub-levees were started from a point immediately behind the center of the exposed face and carried in both directions to connect with the main levee. Until the sub-levee on the banquette was completed efforts were concentrated on that work, but from very nearly the beginning of the fight the three phases of the work were carried on simultaneously, or in the following order: completion of sub-levee on banquette, protection of face of levee, and the building of the sub-levee with the core-wall.

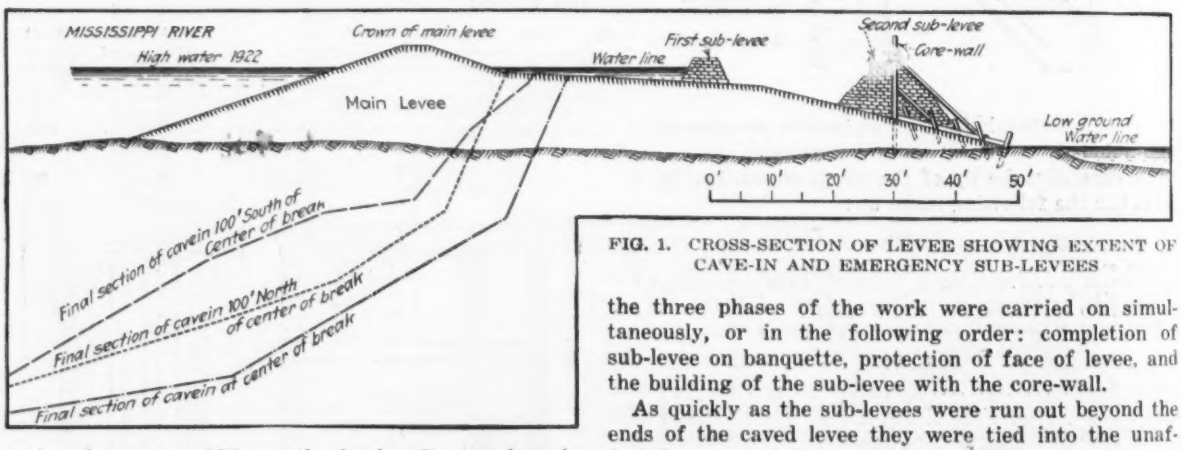


FIG. 1. CROSS-SECTION OF LEVEE SHOWING EXTENT OF CAVE-IN AND EMERGENCY SUB-LEVEES

As quickly as the sub-levees were run out beyond the ends of the caved levee they were tied into the unaffected crown of the main levee. When the first enclosure was being made from the sub-levee on the banquette the river had already begun to pour in. The space between the first sub-levee and the crown of the main levee where it was intact, and between the first and second sub-levees was divided into chambers by means of cross walls so that the fight could be centered on the particular chamber into which the caving might penetrate.

The work on the front, the making and placing of the "mattettes," required some experimenting. At first they were built of cotton bagging sewed on steel mesh, which in turn was fastened to a framework of steel bars. They were made 8 x 40 ft. in size. It was found, however, that they were not flexible enough to fit the section of the caving face. So they were next made of 1-in. mesh chicken-wire covered with two layers of cotton bagging with a 2 x 4-in. stick laced in as a cross-piece at one end, and a 12-in. cylinder compactly filled with rock and then sealed, at the other. The mattette proper was wrapped tightly around the cylin-

FIG. 3. GENERAL VIEW OF BREAK SHOWING TWO EMERGENCY SUB-LEVEES

This picture was taken looking along the first sub-levee, which held the flood. The break in the main levee may be seen in the left middle-ground while on the right appears the second sub-levee with its timber core-wall. The cross-levees shown in Fig. 4 were built later. The ropes crossing the first sub-levee hold the "mattettes" hung over the caving face to protect it against further erosion. Some of these may be seen on the crown of the main levee.

der, and a ¾-in. tie-line attached to the 2 x 4-in. stick. The roll was then carried to the place at which it was to cover the caving face, eased into the water and held until it was thoroughly saturated and all the air had been excluded from the cylinder, and then turned loose to unroll. The mattettes took the position intended for them very nicely. The la' units were 5 ft. wide and 50 ft. long, and had ½-in. steel cross-bars every 10 ft. of length.

As a rule they rolled out until the weight of the cylinder could be felt. They were then securely tied back with the ¾-in. rope. The mats were lapped one over the other, and at some points laid in layers. Just how much good they were is problematical. It is significant, however, that after their use was begun the caving was retarded from 48-hr. intervals to 10-day intervals.

The entire job, as outlined and carried out, involved the moving by hand of 4,000 cu.yd. of dirt in bags, an average distance of 700 ft., the erection of a timber core-wall containing 60,000 ft. b.m. of lumber, fabrication and placing of mattettes consisting of 10,000 lb. steel bars, 10,000 sq.yd. bagging, 5,000 sq.yd. of poultry wire, 12,000 lin.ft. of ¾-in. rope; two electric light units, carbide lamps, tools, equipment, etc., and the feeding and sleeping of 1,000 men. Sixty per cent of this work was done within 72 hours, during which time there was a rainfall of 2 in., and the remaining 40 per cent during the following 3 weeks as the conditions demanded. Eighty per cent of the equipment, tools, and supplies were brought from Helena, a distance of 18 miles. Sacks came 100 miles from Memphis. The light units came 150 miles from Little Rock.

FIG. 5. FRONT VIEW OF BREAK IN MAIN LEVEE

This shows clearly the "mattettes" spread over the caving face of the levee to prevent further erosion.

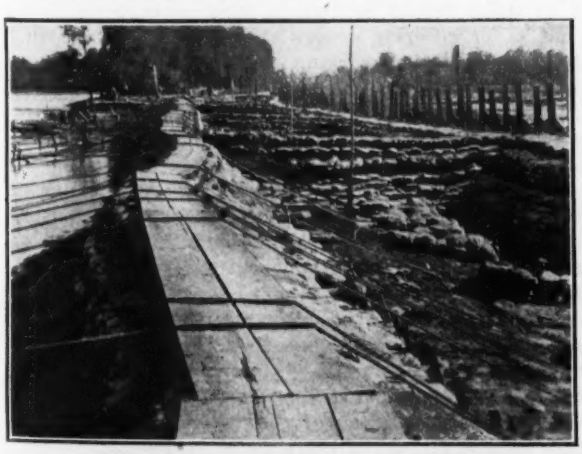


FIG. 4. REAR SLOPE OF LEVEE BETWEEN SUB-LEVEES

The first sub-levee is holding the flood while the second is ready in case of a breach. Note the cross-levees which divide the intermediate area into chambers so that trouble can be localized. The river is to the left.

Work was organized and carried on as follows: The serious break of March 31 occurred at 11 p.m. The commissioners for the Levee District were immediately notified, and after they had made a rapid reconnaissance of the damaged levee they called a meeting of about 25 of the representative business men of Helena. These men included plantation owners, millmen, and business and professional men. The situation was made plain, the need of immediate action emphasized, and a request made for the entire co-operation of all present. The result was that men, tools, and material were rolling towards the scene of the threatened break within three hours.

An office was established in Helena and one at the site of the work. Special telephone service was arranged. Order clerks were appointed, a truck fleet organized, and riders put on the route of the line of supplies. A quartermaster department was established in a large quarterboat furnished by the government. There was some confusion during the first few hours, after which, however, things moved smoothly and surely. Dawn of April 1 saw 600 laborers filling, sewing, carrying and placing sacks in the first sub-levee. Soon afterward carpenters had made a good start on the core-wall of the second sub-levee. Supplies had been delivered to the quartermaster, who fed several hundred at breakfast, and 600 at noon. The men were fed at the rate of 100 every quarter-hour.

FIG. 6. PLACING "MATTETTES" TO PROTECT FACE OF CAVED BANK

This shows the placing of a mattette as originally designed with a wire mesh reinforcement. This was found to be not sufficiently flexible to conform to the face.

Here is shown the placing of a "mattette" of revised design, in which chicken-wire was used to reinforce the cotton bagging. Each unit was 5 ft. and 50 ft. long.

As stated in the beginning the fight was successful and the impending breach did not occur. No intricate engineering problems were involved—no work under ground or above ground. In fact it was all very much on the ground. The job was a problem of organization and execution. Furthermore, it was a problem of organization and execution dependent on the citizenship of the community. We believe that it came through.

It is well to remark here that the success of the fight was due, in a great measure, to the fact that one of the improved highways of the county runs to within one mile of the seat of the trouble. This particular highway has a mixed bituminous wearing surface on a 5-in. concrete base. It connects Helena and Oldtown, and all supplies, materials and men were hauled over it.

The Cotton Belt Levee District is in the Second District of the Mississippi River Commission in charge of Major J. M. Hodges, C. of E., U. S. Army, with headquarters at Memphis. Luther Y. Kerr is assistant in charge of levees, and M. Gardner assistant in charge of channel work. W. K. Monroe is assistant engineer to Mr. Kerr and the writer was retained by the commissioners of the district as engineer. The commissioners of the district are W. F. Craggs, president, H. D. Moore, secretary, and W. H. Howe, all of whom were on the ground in direct charge of the work.

Highway Bridge Survey by U. S. Engineers

A compilation of data on bridges in the Louisville district is to be made by the U. S. Engineer Office at Louisville, Lt.-Col. G. R. Lukesh in charge. City and county engineers in the district are aiding the government in the compilation.

On the Proper Value of Kutter's n for Sewer Computations

Existing Data Based on Actual Sewer Conditions Scanty—Overlooked Federal Bulletins —Suggestion for n

By Charles W. Sherman
Of Metcalf & Eddy, Consulting Engineers, Boston, Mass.

CONTRARY to general impression, the commonly accepted values of n used in computing flow in sewers are not supported by many experimental data. Most of the experiments upon which reliance is placed have been made with clean water, rather than sewage, and by far the greater part of the determinations of n for flow in pipes have been based upon flow in closed pipes under pressure, and upon other materials than those used for sewers. The values of n adopted have been assumed after comparison and upon the basis of analogies, real or fancied, between the conditions existing in the tests and those likely to exist in sewers; or else the coefficients have been adopted by making arbitrary allowances for the assumed effect of the different conditions. The following review of existing data, particularly the too-generally-overlooked Scobey and Varnell-Woodward bulletins of the United States Department of Agriculture, is designed to show (1) that $n = 0.015$ should be used in pipe sewer design; (2) that n for concrete sewers should be 0.013; (3) that tests under actual working conditions should be made to remove such doubts as to the proper values for n as still exist; and (4) that for pipe sewers not flowing full, n is not a constant and therefore Kutter's formula is not properly applicable.

Among the best of the lists of values of n applicable to various cases, is that of Robert E. Horton, published in *Engineering News* of Feb. 24 and May 4, 1916, and reproduced in King's "Handbook of Hydraulics." Mr. Horton recommends for vitrified sewer pipe the value of 0.013 for pipe in good condition and 0.015 in fair condition; for clay drainage tile, 0.012 and 0.014; for brick sewers, 0.013 and 0.015; for cement mortar surfaces, 0.012 and 0.013; for concrete pipe, 0.013 and 0.015. No modification of the value of n is given in case sewage instead of clean water is flowing.

Significance of Slight Change in n—Many engineers do not appreciate how much difference in computed velocity or capacity may result from a slight change in the value of n. Within the ordinary range of sizes

of common sewers, it may be stated that the computed capacity using $n = 0.013$ is approximately 22 per cent greater, and with $n = 0.011$, 50 per cent greater, than with $n = 0.015$.

Of the experimental values quoted in Hering and Trautwine's translation of Ganguillet and Kutter's book but few are in any way applicable to conditions existing in sewers unless the cast-iron pipes under pressure be assumed as comparable. The list includes one earthenware pipe 1.5 ft. in diameter, run under a slight head (Bidder, 1853). Experiments of Eliot C. Clarke, in 1885, upon the Dorchester Bay sewage tunnel of the Boston sewerage system, with the tunnel 7½ ft. in diameter running full and under pressure, showed values of n = approximately 0.014 for a mixture of sewage and salt water, and ranging up to 0.020 for sewage only. Experiments of Fteley and Stearns in 1880 on flow in the Sudbury aqueduct of the Boston waterworks may also be applicable to brick sewers, although allowance should be made for the fact that the experiments were made with clean water.

Metcalf and Eddy's "American Sewerage Practice," Vol. I, p. 80 and following, contains data upon experiments for determining values of n but they relate largely to flow in streams and canals. Those most applicable to sewers relate almost wholly to large conduits and only two of the eight in the list, given below, refer to pipe sewers:

Theodore Horton, 1901. Boston Metropolitan sewers, from 6 to 9 ft. diameter (brick sewers).
F. C. Coffin, 1906. Cambridge water-works conduits, 5½ ft. diameter (concrete).
Bureau of Surveys of Philadelphia, 1909. Large brick and concrete sewers.
James A. Cushman, 1911. Wachusett aqueduct.
John Ericson, 1911. Chicago water-works tunnels, brick lined.
C. F. Schultz, 1912. Cleveland water-works tunnels, brick lined.
H. D. Newell, 1913. 16-, 30-, and 46-in. concrete pipes (for water).
T. Chalkley Hatton. 24-in. vitrified pipe sewer at Carlisle, Pa.

The Only Record Based on Sewer in Use—A search through periodical literature since 1915 has brought to light but one record from which some information as to the actual value of n in sewers can be obtained. H. D. Silliman, in a letter to *Engineering News*, Dec. 2, 1915, describing sewer gagings at Seattle, says:

> The running time . . . . was calculated by using Kutter's constants, $n = 0.013$ for pipe sewers, and $n = 0.015$ for brick sewers . . . . In all the velocity measurements that I have made, I have not found an old sewer that had more than 90 per cent of its calculated velocity using the foregoing constants. Some ran as low as 75 per cent of the calculated velocity.

If we assume observed velocity in a 12-in. vitrified pipe as 85 per cent of the computed velocity, as above, this would correspond approximately to the result obtained by using $n = 0.015$ instead of 0.013. In other words, Mr. Silliman's measurements may be assumed to indicate the actual value of n in pipe sewers to be approximately 0.015.

Valuable Federal Bulletins—In view of the unfortunate scarcity of experimental data applicable to pipe sewers and to concrete sewers of small and moderate sizes, which have hitherto been available, two recent professional papers of the United States Department of Agriculture deserve the attention of hydraulic engineers, comparatively few of whom seem to know of their existence. Reference is made to "The Flow of Water in Concrete Pipe," by Fred C. Scobey, and "The Flow of Water in Drain Tile," by D. L. Yarnell and S. M. Woodward, both published in 1920.

Mr. Scobey's Paper describes a number of experiments made by him and also brings together all of the available data relating to other experiments on flow in concrete pipes and conduits, not only when flowing full under pressure, but also when flowing part full, the latter being especially applicable to conditions ordinarily obtaining in sewers. These include one 10-in., one 22-, and one 31-in. pipe, but no others less than 36 in. in diameter; and the data compiled are, therefore, inadequate upon which to base conclusions with regard to flow in concrete sewers of small size, although they are reasonably complete for large conduits. Mr. Scobey's conclusions regarding the proper value of n are as follows:

> For first-class pipes and conduits carrying filtered water, or water from which deposits or growths do not accrue, both surface and joints being practically perfect, $n = 0.0115$;
>
> For well made pipes and conduits with first class joints, smooth monolithic pipes or conduits when new and clean, with thoroughly good surfaces but not as smooth as those classed as glazed, corresponding in general to the surface obtained by a wash coat, $n = 0.012$;
>
> For well made pipes carefully jointed or monolithic, without appreciable irregularities at the joints, or for waters containing a small amount of sewage, $n = 0.013$.

It should also be noted that the experiments indicate that the value of n increases slightly with the size of the conduit, or with increased values of r for the same conduit; or, put another way, a slightly larger value of n should be assumed for a 6-ft. conduit than for a 2-ft. conduit with similar interior surfaces.

The present writer concludes from these experiments that for concrete sewers with clean interior surfaces, made on metal forms, with thoroughly good workmanship, the value of n should be taken at about 0.0125; and that making allowance for the effect of a surface coating of grease, and possible small deposits of sewage solids, a value of not less than 0.013 should be used.

The Yarnell-Woodward Bulletin—The most significant available data upon actual values of n in pipe sewers are those given by Yarnell and Woodward in their already-mentioned paper. The drain tiles experimented upon were of concrete and clay, nearly all in 1-ft. lengths, and the joints were made without mortar by butting the pipes together. The experiments were made with the greatest care, the pipes being laid in a wooden trough and surrounded by earth. Proper grades were obtained by changing the inclination of the trough, and uniform depth of water was maintained by adjusting movable dams. Experiments were made for various depths of flow, from approximately half-full to substantially full, and with pipes from 4 to 12 in. in diameter. A few experiments were also made with 10- and 12-in. pipe purposely laid with bad alignment.

These experiments show that with pipes well laid and running substantially full, the value of n in Kutter's formula was approximately 0.011. Clean water was used in the experiments, and a higher value of n would necessarily be assumed for sewage.

Bearing in mind the fact that drain tile are not distorted in burning to the extent that is common in vitrified sewer pipe, and that the surface is rougher in sewer pipe than in most drain tile, it is probable that

further allowance should be made for this in designing sewers, by using a higher value of n. The experiments with 10- and 12-in. drain tile in poor alignment indicated values of n of about 0.012 and 0.013, and these may probably be assumed as more nearly the correct values for sewer pipe with clean water flowing.

Experiments upon the flow of sewage in sewer pipe seem to be entirely lacking (except Mr. Silliman's gagings, the details of which are not reported), and the still further allowance which should be made in assuming a proper value of n for design, on account of the difference in character of the liquid, and also because of the effect of the coating of grease and slime upon the inside of the pipes, and possible deposits of grit or of organic matter, can only be estimated approximately. It seems to the writer that it would be prudent to assume not less than 0.015 for n in pipe sewers.

When Pipes Not Substantially Filled—Yarnell and Woodward's experiments show that when the pipes are not substantially filled, materially higher values of n obtain, and no general formula by which the flow for any depth could be satisfactorily computed was discovered. In general, the values of n ranged from 0.011 to 0.014 with pipes partly full when using clean water, in the case of the well-laid pipes, and from 0.011 to 0.020 for poorly-laid pipes, but no consistent relation between the depth of flow or the hydraulic mean radius and the value of n was developed. The authors suggested several formulas which represent the results of their experiments with a fair degree of accuracy, one for 0.5 depth, another for 0.6, and so on; but how far any of these might be applicable to estimating flow in sewers is questionable, as there seems to be no satisfactory basis for allowing for the difference in the character of the conduit or for the effect of sewage instead of clean water, or for accumulations of grease or deposits, especially as the same value of n as for a full pipe cannot be used.

The data contained in Scobey's paper are sufficient to show that Kutter's formula is applicable to computations of flow in concrete sewers, say 3 ft. in diameter and upwards, with a good degree of accuracy. Perhaps slightly larger values of n should be used for large than for small sewers, although it is probable that the effect of slime and grease on the interior surface, and of deposits of solid matter, would be proportionately less in large than in small sewers, so that it appears reasonable to adopt a single value for design of concrete sewers of any size. It appears that a value of $n = 0.012$ for clean water, and $n = 0.013$ for sewage, is probably applicable to such surfaces as would ordinarily be obtained in sewers built on metal forms.

With Pipes Substantially Full—For pipe sewers, the Yarnell and Woodward data indicate that, with clean water flowing and with the pipes substantially full, a value of $n = 0.011$ is applicable to drain tile in perfect alignment, and (probably) $n = 0.012$ to 0.013 for sewer pipe. Larger values should be used for sewage, not less than 0.014, and probably 0.015 would be safer. Mr. Silliman's observations, that actual velocities were materially less than those computed with $n = 0.013$, the difference being approximately such as to indicate that the actual velocities would correspond closely with computed velocities for $n = 0.015$, further confirm the view that the latter value should be used in design. The utilization of the full capacity of a sewer is contemplated in design, and this is the condition in which Kutter's formula has been found to apply—i.e.—a pipe substantially full but not under pressure.

Yarnell and Woodward's experiments have, however, demonstrated that Kutter's formula is not satisfactory as a basis of estimating flow in sewers running partly full. Under such conditions, other factors than the condition of the surface have an effect upon the flow, and no satisfactory basis of allowing for such influence has yet been found. Attempts to gage the flow in pipe sewers by observing the depth and slope, and computing the velocity by Kutter's formula, using assumed coefficients, must, therefore, be recognized as unsatisfactory, since the actual variations of n with pipe partly filled have been found to be such that errors of 50 per cent or more might readily result.

Conclusions as to Concrete and Pipe—The data available and reviewed above seem to indicate that in the design of sewers under usual conditions, values of $n = 0.013$ for concrete and 0.015 for pipe sewers should be used. These values have been employed in the practice of the writer's firm for some time, and are in accordance with the recommendations in "American Sewerage Practice," Vol. I, p. 94, except that it is there suggested that a value of $n = 0.012$ should be used "for concrete sewers of large section and best work laid on slopes giving velocities of 3 ft. per second or more." It now seems to be definitely shown that, for a given character of surface, somewhat larger values of n are found for large than for small channels, and it is therefore believed that a value of 0.013 should be used for all concrete sewers, if well-made with smooth interior surfaces.

It should be noted further that the use of the above values of n—0.013 for concrete and 0.015 for pipe sewers—is justified only when no other losses than those due to friction are to be included. In cases where there is appreciable curvature, allowance should be made for its effect by estimating it separately, or by arbitrarily assuming an increased value for n. Changes of direction in pipe sewers are usually made in the manholes, and it is a common practice to allow an additional drop in such manholes, which is assumed to be sufficient to overcome the resistance of the curve. Unless such an allowance is made, it is probable that a higher value for n than 0.015 should be used in the design of pipe sewers.

Because satisfactory experimental determinations of n for sewers are few in number, particularly for pipe sewers, it is much to be desired that advantage should be taken of every opportunity for making actual measurements of velocity and comparing them with slope, cross-section, character of surface, etc. Such information may perhaps make possible the future development of a more satisfactory formula for flow in sewers.

Buffalo Water Consumption Falling, but Still High

Since the campaign against excessive water waste was begun at Buffalo in 1917, the daily per capita water consumption has fallen from 339 gal. for the fiscal year 1916-1917 to 227 gal. for 1921-1922. During the same period the pumpage has declined from an average of 168 to 117 m.g.d. and the total yearly pumpage from 61.49 to 42.76 billion gallons. George C. Andrews is Water Commissioner of Buffalo.

Failure of Concrete Arch Bridge Due to Pier Washout

Undermined Shale Foundation Tips Pier Supporting 90-Ft. and 110-Ft. Spans—Arches Fall Six Weeks Later

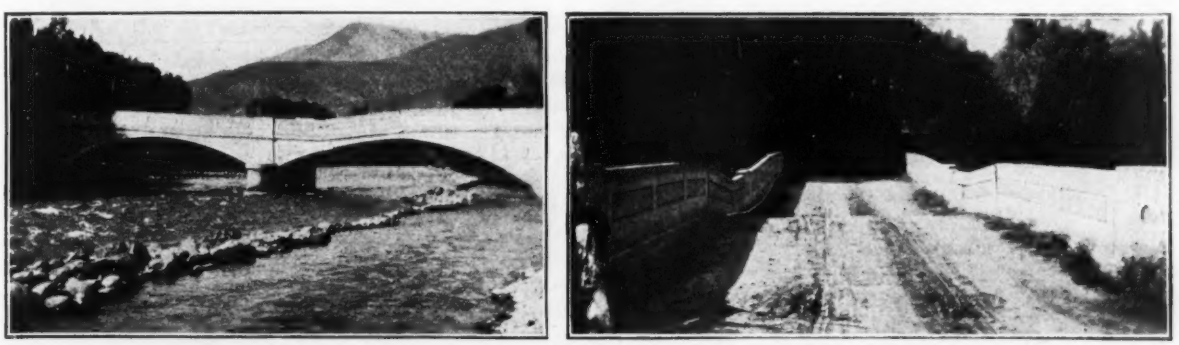
TWO spans of a concrete arch highway bridge crossing the Eel River near Brazil, Ind., known as Brunswick Bridge, collapsed on April 20, as the result of undermining of one pier several weeks before. The bridge consisted of a central 110-ft. span flanked on either side by a 90-ft. span. It was built in 1917 to replace a 190-ft. span washed out by flood. The design was made by Daniel B. Luten, and the National Bridge Co. built the structure.

The following account of the washout and failure has been prepared by Mr. Luten at the request of *Engineering News-Record:*

"In March, 1922, a flood of substantially the same height as the record high water of Easter week, 1913, undermined one of the piers, which tipped 18 in. upstream, indicating a settlement of about 4 in. under its upstream end. The arches remained standing, however, and traffic was continued across the bridge, although the bridge was posted as dangerous. Recommendations were made for saving part of the structure, but the high water continued for so long and to such an extent that the proper support could not be provided, and after five or six weeks the two spans supported by the undermined pier collapsed. The third span remains standing.

"The design called for piled foundations under the abutments 19 ft. below low water, and under the piers 23 ft. below low water and 11 ft. below the deepest part of the stream. It was found impossible to drive piling more than 4 ft. in the south abutment, and excavation continued 4 ft. deeper, when shale was encountered. The north abutment was placed on coal, without piling, at the depth required by the plans (19 ft.), and the two piers were placed on the shale strata at their required depth (23 ft.). This shale, while apparently a secure footing, must nevertheless have been attacked by the currents, causing the collapse of the two spans.

"The punishment sustained by the two arches, which remained standing for over a month on a pier subjected to unequal settlement, is more than paralleled by the bridge across the Eagle River at Gypsum, Col., shown in the accompanying photographs. The two spans are 60 ft. each. The pier was undermined by a flood in 1916 and settled 10 in. at one end and 4 in. at the other, but the arches remained standing, in the condition shown in the view. Traffic on a transcontinental highway has continued across the structure to the present time without repairs, which were postponed by the county because of the cost."



EAGLE RIVER BRIDGE STILL STANDING, SIX YEARS AFTER PIER SETTLED

A similar pier settlement at the Eel River bridge near Brazil, Ind., resulted in collapse of the arches after six weeks.

Water Company Sued for Typhoid Damages

Suits for damages totalling nearly $300,000 have been brought against the Blue Ridge Water Supply Co. of Walnutport, Pa., by some thirty residents who allege that the supplying of polluted water caused typhoid, sickness and death. *Engineering News-Record* is informed by T. McKeen Chidsey, of Easton, Pa., counsel for the plaintiffs, that owing to water shortage the flow of a spring was diverted to one of the water company's reservoirs through an open channel. It is alleged that this channel received pollution from various sources, including the overflow from a privy. It is maintained that this spring should have been protected from possible contamination and that the water should have been conveyed through closed conduits. Mr. Chidsey states that under Pennsylvania practice the plaintiffs in such cases "need to aver and do aver only the fact that they drank the water and that the water was polluted, due to neglect."

From C. A. Emerson, Jr., chief engineer, Pennsylvania Department of Health, *Engineering News-Record* learns that of 53 cases of typhoid during the outbreak, about 80 per cent had onsets from June 13 to 21, 1921. All the persons suffering from typhoid had used the public water supply and no other probable common cause was found. Laboratory findings of the State Department of Health indicated sewage contamination of the water but no active typhoid case or carriers could be located on the watershed. From circumstantial evidence it seems that the outbreak was caused by the water supply. One of the springs forming the supply, Mr. Emerson states, was not far from a public highway and may have been polluted while being used by an itinerant typhoid carrier.

Walnutport borough has a population of about 1,000. The water supply in question, Mr. Emerson states, was never approved by the State Department of Health. In fact, its existence was only learned of by chance a few weeks before the outbreak.

Grade Reduction Increases Train Loads on Coal Road

Location of New Second Track on Louisville & Nashville R.R. Avoids Grade for Loaded Traffic—Tunnel Opened by Deep Cut

A COMBINATION of relocation, grade reduction and double tracking, together with some interesting structures and the opening up of an old single-track tunnel by a new double-track cut, is included in a 5½-mile stretch of improvement now approaching completion on the Cumberland Valley division of the Louisville & Nashville R.R. This improvement, estimated to cost $1,254,700, is designed to relieve congested traffic conditions on an overtaxed coal carrying division, to increase the train load about 60 per cent, and to reduce the high operating expenses incident to hauling heavy coal trains on a grade of 1.25 per cent for a distance of 2.7 miles.

The Cumberland Valley division, leaving the main line at Corbin, Ky., runs southeast and south to Middlesborough and then approximately east to Norton, Va. From Acosta, on this division, the Kentucky and Virginia division extends eastward to Harlan, Ky. Both of these divisions serve large coal districts, so that there is a heavy northbound coal traffic from Acosta to Corbin. Beyond the latter point the bulk of the traffic moves north to Cincinnati and Louisville, a small proportion moving south.

Physical Conditions and Traffic—At Emanuel, Ky., 183 miles from Louisville, the line leaves the valley of the Cumberland River and climbs through rough country to an interior plateau. This ascent is made mainly by a grade of 1.25 per cent 2.7 miles long to the summit at Arkle, near mile 180. Beyond this, the line has moderate grades to Corbin. The grade is opposed to the heavy northbound traffic, and although helper engines are used it is a cause of delay in handling the traffic. The standard trainload at present is 3,150 tons for a 154-ton locomotive of the 2:8:2 type, but when the present work is completed this will be increased to 5,300 tons. The improvement consists in lowering the summit elevation and building for the northbound traffic a new direct line having a ruling grade of only 0.65 per cent. Except for some minor changes in location the original line will continue to be used for southbound traffic. The general conditions are shown in the plan and profile, Fig. 1.

From Corbin to Arkle (Sta. 405) the line is now double track, but from Sta. 393 to 405 the grade has been lowered. Beyond this point the double-track roadbed has been extended to Sta. 444. Here the new second track diverges from the original line on a new location. Being on a more direct course it crosses the original line at two points: At Sta. 555, near Emanuel, and again at Sta. 600 near Bailey's. The first crossing, with an angle of 41 deg., is made by an oval underpass or tunnel 158 ft. long, through the new fill. Parallel with it is an underpass for a road diversion. The second railway underpass has a rectangular opening with girder roof and ballasted deck. The two lines come together again at Sta. 639, which is the north end of a middle passing track. When other grades of 0.65 per cent on this division have been reduced the long 0.65 per cent grade between Bailey's and Arkle will be the ruling grade. Trainloads will then be increased and pusher engines used on this grade.

Curvature between Arkle and Bailey's amounts to 272 deg. on the new track as compared with 623 deg. on the original line, the sharpest curves being 7½ deg. on the former and 6 deg. on the latter. Grades are compensated for curvature at the rate of 0.035 per cent per degree of curve. The distance between the two points is 29,040 for the new track, with 149 ft. rise and fall; on the old line it is 30,320 ft., with 166 ft. rise and fall. For the 5½ miles of new second track there was about 625,000 cu.yd. of excavation, most of this being solid sandstone rock. About 6,700 cu.yd. of reinforced concrete was required, nearly all of this being in line structures.

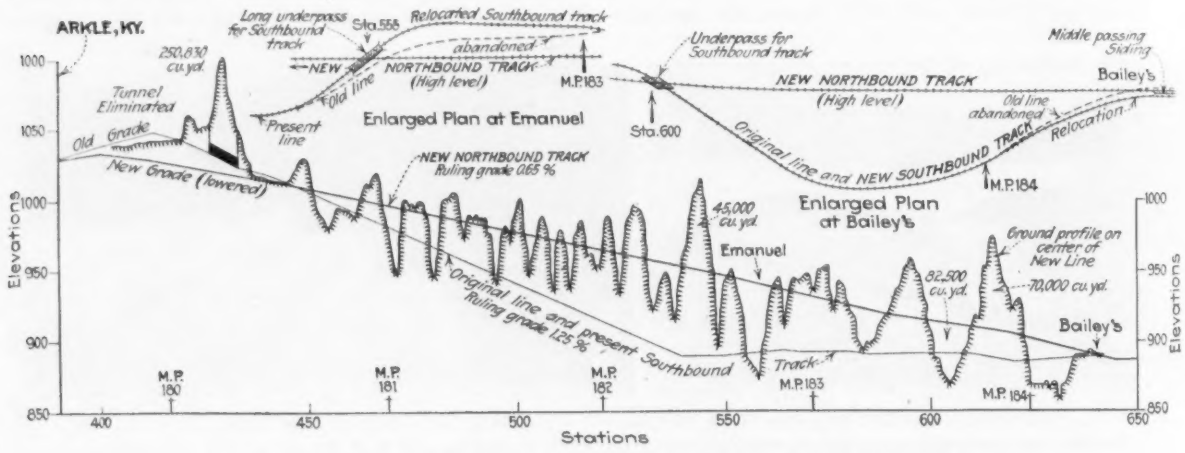


FIG. 1. PROFILE OF OLD AND NEW LINES ON GRADE REDUCTION WORK

Cut Replaces Tunnel—Grade revision on the present location at the north end of the work will lower the grade to a maximum of 22 ft. below the old subgrade. This includes the elimination of the single track Brafford Gap tunnel, 725 ft. long, by an open cut with its grade about 14 ft. below that of the tunnel. This cut, which has a maximum depth of 90 ft., required the removal of more than 250,000 cu.yd. of material, mostly solid rock. A typical section through the tunnel and cut is shown in Fig. 2.

In making the new cut, the surface was first ex-

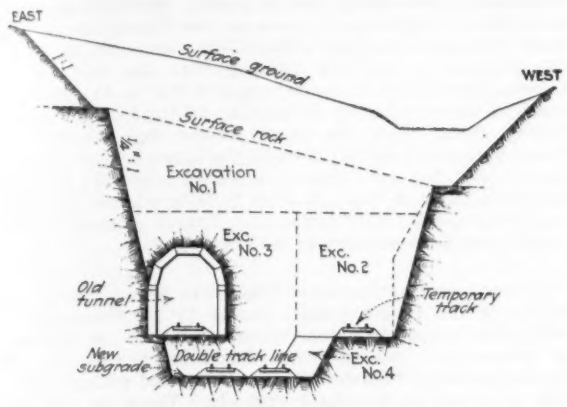


FIG. 2. SECTION OF DEEP CUT REPLACING TUNNEL

cavated for the full width down to within 10 ft. of the tunnel roof. A second cut, with practically vertical sides, was then carried parallel with the tunnel and down to the same grade, leaving nearly 20 ft. of material between the tunnel wall and the cut. In this second cut was laid a temporary track for traffic. With traffic thus diverted, a third cut opened up the tunnel, removed the material between it and cut No. 2 and carried the excavation down to the new subgrade elevation. A single track was laid on this roadbed and traffic diverted to it. A shallow fourth cut then widened the roadbed for the second track. As a final step the rough west side of cut No. 2 was dressed to a slope of ¼ on 1.

Concrete Underpasses—Owing to the flat angle of 41 deg. for the crossing of the two lines at Emanuel, an underpass or tunnel 158 ft. long is required to carry the old line through the high 55-ft. fill for the new line. This reinforced-concrete structure, Figs. 3 and 4, is of oval section, with a maximum clearance width of 18½ ft. and a height of 26 ft. above base of rail. The sides extend 2½ ft. lower and are shaped to form concrete side ditches.

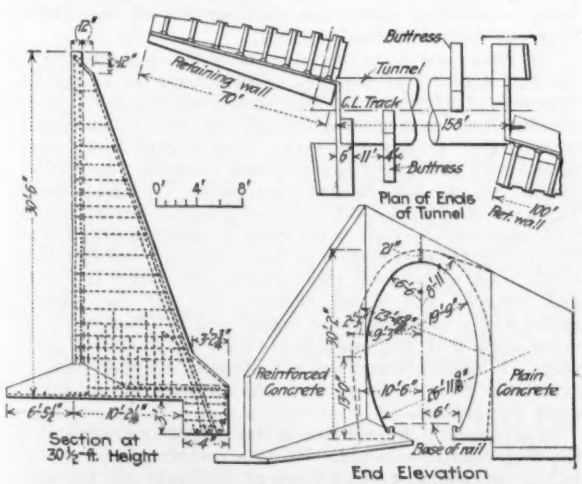


FIG. 4. CONCRETE UNDERPASS AT EMANUEL
Old line carried through this tunnel over which new line passes on 55 ft. fill.

Lateral thrust at each portal, due to the angle of crossing and the height of fill, is resisted by an extension of the portal wall and by a buttress 11 ft. back of the portal, as shown in Fig. 4. The barrel of the tunnel, 21 in. thick at the crown and 27 in. at the haunches, was built in lengths of 15 ft., with the reinforcement extending through the construction joints. Beyond each portal a long wing wall is required on one side to keep the toe of the slope clear of the track. These walls are of the counterfort type and have a maximum height of 37½ ft.

An underpass for a country road diversion, through the same fill, is a rectangular structure with opening 20 ft. long and 14 ft. wide, beyond which are wing retaining walls of the counterfort type. The roof has two heavy girders built monolithic with a 10-in. deck slab 15 ft. wide, having curb walls to retain the ballast. A structure of similar type, but with opening 16 ft. wide and 22 ft. high, forms the second track underpass near Bailey's.

Construction Methods—Practically all excavation was handled by steam shovels loading trains of 6-yd. and

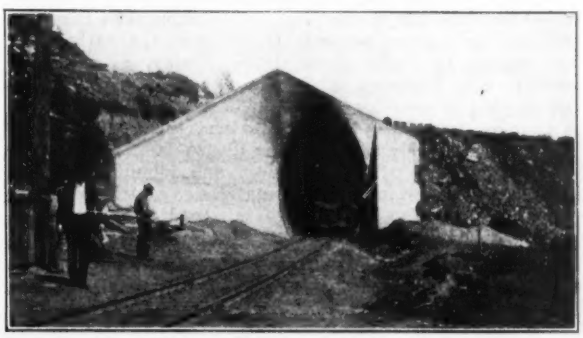


FIG. 3. UNDERPASS FOR OLD TRACK BEFORE FILLING

8-yd. dump cars, these cars being dumped on light construction trestles at the fills. Excavation for the tunnel underpass was largely in solid rock and was done with a small revolving shovel. The downhill side of the underpass was entirely in the open and the rock was excavated on the uphill side for a distance of about 2 ft. from the outside lines of the arch and wing walls.

The fill across this structure was made in two lifts. For the first lift a temporary trestle was constructed with its deck approximately 4 ft. above the top of the masonry, and the fill from this was made with a soft, friable sandstone obtained from a cut about 2,000 ft. north of the underpass. This lower section of the fill was built to full width between slope stakes and the masonry of the underpass was fully covered and protected with the soft sandstone before the second lift of the fill was made. In blasting, this rock broke up to such an extent that in making the fill it was easy to keep the pressure equalized on either side of the structure in order to avoid damage.

Engineers and Contractors—Work on this improvement was begun in September, 1920. That portion north of Emanuel was done by the Nichols Contracting Co., Atlanta, Ga. The southern portion was handled jointly by the Codell-Byers Construction Co., Winchester, Ky., and U. S. Tackett, Mount Sterling, Ky. Ballasting and tracklaying was done by railway forces.

All work was planned and carried out under the direction of W. H. Courtenay, chief engineer, Louisville & Nashville R.R., and G. R. Smiley, chief engineer of construction, with J. M. Parker as resident engineer.

An Economic Foundation for Highway Progress

By Thomas H. MacDonald
Chief, U. S. Bureau of Public Roads, Washington, D. C.

Address Delivered at the Highway Transport Session of the Annual Meeting of the Chamber of Commerce of the U.S.A., Washington, D. C., May 16, 1922.

THERE is difficulty in properly allocating the earnings of the highway among the different services which it performs. Too many studies have been made for the purpose of proving a pre-determined conclusion. All the aspects of highway improvement are so modified by the particular conditions of the locality, small or large, that many dogmatic assertions, predicated upon insufficient or circumscribed data, which we have accepted as almost axiomatic, fall down when examined in the light of real fact.

Fallacies Accepted — For example, it has been accepted as a tenet that highway bonds shall be issued for a shorter period than the life of the road. The Cumberland Pike, the first and only great national highway of the early days, was opened to traffic about 1818. Today, after a full century, that highway is still in existence, rehabilitated and carying an ever-increasing traffic. It is true that, due to changes in overland transportation, there was a long period when this highway fell into disuse and disrepair, but today, with the surfacing repaired and rebuilt, the same road-bed and most of the same waterway structures are serving traffic. The extension of this road from Baltimore to Cumberland, originally a state project, was resurfaced in recent years at a nominal cost. This light surfacing was placed for horse-drawn traffic, but with continued maintenance and necessary reconstruction from time to time, is now carrying heavy automotive traffic. Under the theory just mentioned, for how long a period would the bonds, had the road been so built, have been proper? Apparently the road is in better condition today than it has ever been in the past.

The term "permanent roads" is a fallacy which is responsible for more or less of the unsound theory which has been advanced with reference to bond issues. There are certain of the essentials of road construction, such as the road-bed and drainage structures, that can be so built that the deterioration is so slow that they may be properly termed "permanent." Road surfaces of whatever type deteriorate. Maintenance should begin as soon as the surface is thrown open to traffic, and the higher the cost of the road, the more careful in detail should be the maintenance.

There is also the fallacy of the imposition of detailed and arbitrary legal limitations upon the character and weight of the loads which shall use the roads. Proper regulation, within certain reasonable legal limits, of the use of the roads is an administrative matter. Even in a single state conditions vary to the extent that loadings which may be carried without deterioration of some road surfaces will inflict untold damage upon others. Yet under the average regulatory law the utility of the best roadways is not realized in full, nor is the safety of the lesser capacity roadways assured.

Research in the field of the weight of loads that can be carried by different road surfaces is revealing definite information. The influence of subgrade soils, tire equipment, distribution of the loads to the wheels, the speed and many other variables is too complex to be written into law. The seasonal variation alone in the carrying capacity of the road-beds, due to moisture conditions, is one of the most serious of all causes of road damage, and for this single reason the highway authorities must be given wide discretion in traffic regulation.

There are many other fallacies which must be cleared away before we can hope to reach sound conclusions as to far-reaching permanent highway policies which will justify themselves over a long term of years. Our total expenditures for all highway purposes in the United States last year were approximately $600,000,000. An examination of the progress in highway building over the past ten or twelve years indicates a very serious lag in the development of the road-bed in comparison to the increase in the rolling stock. This lag is so serious that there is an insistent demand on the part of the large body of vehicle owners that the providing of improved road-beds shall be hastened. This demand in turn is followed, and properly so, because of the very large expenditures required, by the equally insistent question of who shall pay.

Four Classes of Service — There can be no question as to the service that highways render (1) to the owner of the motor vehicle privately operated; (2) to the operator of motor-truck lines and motor-bus lines, the granting of franchises being followed by a real financial return; (3) to real property in the rural districts. There is, although more questions may be raised, a real service rendered by the rural highway (4) to the property within the urban limits, or, if more acceptable, to the people as a whole within the cities. All foodstuffs originate upon a highway, some place, and the nearer to the district that the perishable foodstuffs, such as garden truck, milk, eggs and butter, can be produced, and the more directly and quickly they can be transported from their point of origin to these people, the cheaper will be the cost and the better will be the quality.

Under these four classes may be grouped the major services which are rendered by the highway, but these do not bear a constant relation to each other, nor does the highway maintain a constant relation to each of these. The truck gardner is more dependent upon improved highways than is the farmer who raises only annual crops.

Thus the relative share of the cost of highways may not remain constant, but it is difficult to harmonize with the tenets of fairness and equity any plan of financing which does not distribute some part of the cost to each of these four services.

The 7-Per Cent System—A proper financial policy cannot be established unless there is functioning an efficient, stable highway administration. This applies regardless of the unit that is under consideration. With the exception of a very few states it is apparent that the major highway development for the next decade and probably longer will be upon the so-called 7-per cent system which is now being established under the requirements of the Federal Highway Act of November, 1921.

We have now on a national scale the inauguration of the first cardinal principle of efficient highway administration—the classification of the roads into selected systems. On the 7-per cent system federal and state funds will be concentrated until completion. This classification, recognizing with full credit the progress made by many of the states before the federal enactment, is fundamental. Through its operation the roads of greatest importance are first improved and all work done is accumulative toward the completion of a system of interconnected and correlated traffic lines as between the communities within the states and between the states themselves. As the highway systems are completed the traffic will become more and more organized and concentrated on the improved roadways. If these systems are not properly selected they will eventually have to be revised and so much of the investment jeopardized.

In sequence of importance is the proper improvement of the highways so selected. Up to a certain point the steps in the improvement of all types of roadways are the same. The selection of the best location, the building of the road-bed by excavation, filling and draining, the building of the necessary culverts and bridges, the building of guard rails, approaches and all the incidental construction will be as carefully and thoroughly done under an efficient highway administration for all types of highways.

Selection of Type—The selection of the type of roadway surface is the all-important item from the standpoint of the highway service and highway finance policies. The service to be rendered must determine the selection of the type of highway. Here again research and investigational studies are rapidly fixing within reasonably definite limits the kind and volume of traffic which can be carried by the different roadway surfaces within reasonable maintenance costs. Such a selection will determine the proper financial policy, for it will provide the basis for the establishment of an annual highway expenditure budget. The major items of the budget will include (a) maintenance, (b) reconstruction, (c) new construction. Reconstruction is included separately from maintenance for in the progress of highway improvement the replacement of old surfaces is usually by a higher-type surface and consequently the road is improved beyond its first condition.

The amounts needed for maintenance and reconstruction will be determined from the records and reports of the condition of roads in the system. The new construction requirements in the majority of the states are capable of absorbing all the funds that can be made available, so it is in the fixing of this fund that the most care should be exercised. It should be sufficient, however, to complete the first construction of the state system within the shortest period consistent with good management and the maintenance of competitive prices.

Basis of Financial Policy — It is believed that a proper financial policy will require first that all of the maintenance funds be met from the revenues derived from the road user; second, that the costs of reconstruction be met from the revenues derived from both the road user and from states taxes, the relative percentages being different for different states and for the different types of roadways built; third, after deducting the federal aid, the cost of new construction should be divided between the road users and other state taxes from both urban and road sources.

Just how the respective revenues for reconstruction and new construction shall be divided between revenues from the road users and other classes of revenues, and how these costs, once apportioned, shall be divided to the several classes of road users and the different classes contributing to the other revenues, must be determined upon the most thorough research and investigation. It has been stated that the total expenditures for rural highway purposes in the United States for the past year were approximately $600,000,000. These revenues came from the following sources:

Local Road Bonds	33%
Federal Aid	14%
State road bonds	7%
State taxes and appropriations	12%
County, township and district taxes and assessments	14%
Motor vehicle revenues	19%
Miscellaneous	1%

Federal aid and motor vehicle revenues constituted 33 per cent; the remaining 67 per cent either comes directly or will eventually be paid from state and local taxes. It is believed that a very considerable readjustment of these sources of revenues must be made, so that a larger percentage will be paid by the road user and a lesser percentage from state or local taxes. This statement of motor vehicle revenues is not fairly representative of the total funds collected directly or indirectly from the motor vehicles, for our estimates show the following revenues paid during the fiscal year 1921:

Federal taxes paid by manufacturers on passenger cars and motor trucks	$115,546,249
State registration fees	122,478,654
Personal property taxes	52,500,000
Wheel and privilege license	3,636,243
Gasoline tax, 17 states, calendar year 1922, estimated	11,000,000
Total	$305,161,146

The total of $305,161,146 is equivalent approximately to $30 for each car and truck registered during 1921. This total sum, it will be noted, amounts to over one-half of the total estimated road expenditure for 1921.

Consider also the question of gasoline consumption. It is probable that the total gas consumption for use in operating automotive vehicles is not far short of 4,000,000,000 gal. per year. An advance of 1 cent in the price of gasoline on the annual consumption would amount to approximately $40,000,000.

Costs Classified — Facts as to the type of construction which is going into the road building program must also be given consideration. For over 11,000 miles of federal-aid roads involving a total cost of over $188,000,000, the surfacing cost is 60 per cent and the remaining 40 per cent is made up of: Grading, 22 per cent; structures, 14 per cent; shoulders, 1 per cent; engineering, 3 per cent. That is, 40 per cent of the expenditures were for the permanent features of the road. The greater part of the expenditures for surfacing can be rightfully considered in the same class, for it is being successfully demonstrated that by supplementary construction, such as the placing of new surfaces and widening by addition of shoulders, the greater part of the investment can be continually maintained and thus preserved indefinitely. Expenditures of this class fall into the category of maintenance and reconstruction, and if continuance of these two can be relied upon the original investment is preserved indefinitely. Therefore, little fault can be found with the soundness of the financing if bonds are issued for new construction provided that the original investment is thus continually preserved.

Of all these requirements it appears that the funds for the new construction in the amounts that will be needed will be the most difficult to secure. The public should not be called upon to bear this entire cost as an annual expense. Rather is it fair to distribute these costs over a period of years extending beyond the time of the maximum expenditures for new construction. It is not doubtful that succeeding generations will enjoy the use of the highways which are being built now, and there is nothing unfair in pursuing a financial policy which distributes a portion of the cost beyond the immediate period. No enterprise requiring funds in the large amounts that they will be required for the new construction of highways can go forward without anticipation of revenues.

Six Principles—Experience in the administration of highway work has already established certain definite principles without the observance of which it would be highly unsafe to resort to bond issues. The major principles may be outlined as follows:

1. As a general proposition state, not local, bonds should be issued for the building of the state highway system. In any case the total amount of bonds to be issued for any one year or over a period of years in any state should be subject to the control of one central body.

2. Sufficient revenues must be derived from the users of the highways to pay all of the maintenance and a percentage of any reconstruction charges.

3. All bond-built highways ought to be maintained under the direct supervision of the state highway department, which also must have jurisdiction of the revenues from the road users. The proper maintenance of all bond-built roads must be considered a first lien upon such revenues.

4. The proceeds of bonds must be devoted to a system of roads so devised that as the system is completed these roads will in fact continually serve the major traffic in the vicinity. This means that the only safe sequence of improvement is in the order that the different sections of the system serve the traffic.

5. Bonds should not be issued in an amount beyond the ability of the traffic of the present and immediate future to pay revenues sufficient for the proper maintenance of the roads built from the proceeds.

6. The type of roads built with bonds should be adjusted to the traffic which they will be called upon to bear within the reasonable future.

It will be noted that little has been said as to the uses which are to be made of the highways, but it must be remembered that the whole question of highway transportation is in its infant stages. Careful investigations and studies are now going forward to determine both the

economic limitations of highway transport and of the necessarily adjusted highway construction. We have made rapid progress during the past two years toward such determination, and the suggestions which have been made are based upon an administration of a highway program predicated upon the results and determinations of these scientific researches and investigations.

If permanent policies can be adopted and carried forward without change over a period of years the necessary roads can be built without undue burdens upon the public. The result will depend upon foresight and adherence done by foreseeing now and adhering to safe and sound financial policies.

Large Hollow Concrete Blocks Form Dock Wall

Blocks 16 x 15 x 3½ Ft. Built in Wharf and Retain Solid Fill—Concrete and Broken Stone Placed in Cells of Wall

A DOCK-WALL or wharf of 18-ton cellular concrete blocks built up like ashlar masonry is a novel type of structure constructed in the enlargement of shipping facilities for the Petoskey Portland Cement Co., at Petoskey, Mich. This wharf, which is for shipping cement and rock and for receiving coal and supplies, is on the south side of Little Traverse Bay and is exposed to the action of waves and heavy ice. As shown in Fig. 1 the construction consists of about 400 ft. of concrete dock wall with filled ground behind it for a width of 400 ft. from the present shore line for

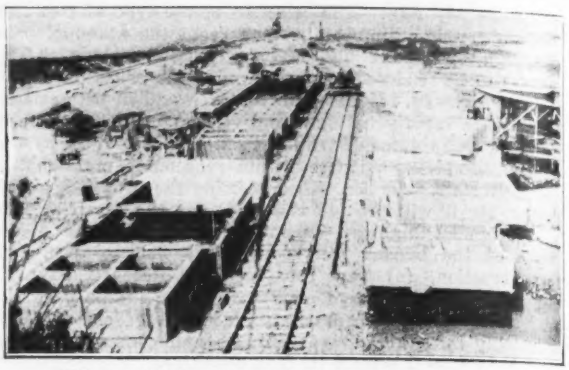


FIG. 2. CONCRETE BLOCKS IN CASTING YARD

capping has expansion joints at intervals of 64 ft. Its face is protected by two lines of fender timbers bolted to the face and by 3-in. hemlock planking which extends 5 ft. below the water line.

Blocks 16 x 15 ft. in plan and 3½ ft. high are used in this wall, each block having four large cells, as shown. The walls and partition are 8 in. thick and the front and back walls extend beyond the side walls so as to form pockets between adjacent blocks. These pockets are filled with broken stone. There is no dovetailing or interlocking of the blocks, nor do they break joint, the wall being built up in 16-ft. lengths with vertical joints.

In construction, the courses of blocks are lined up

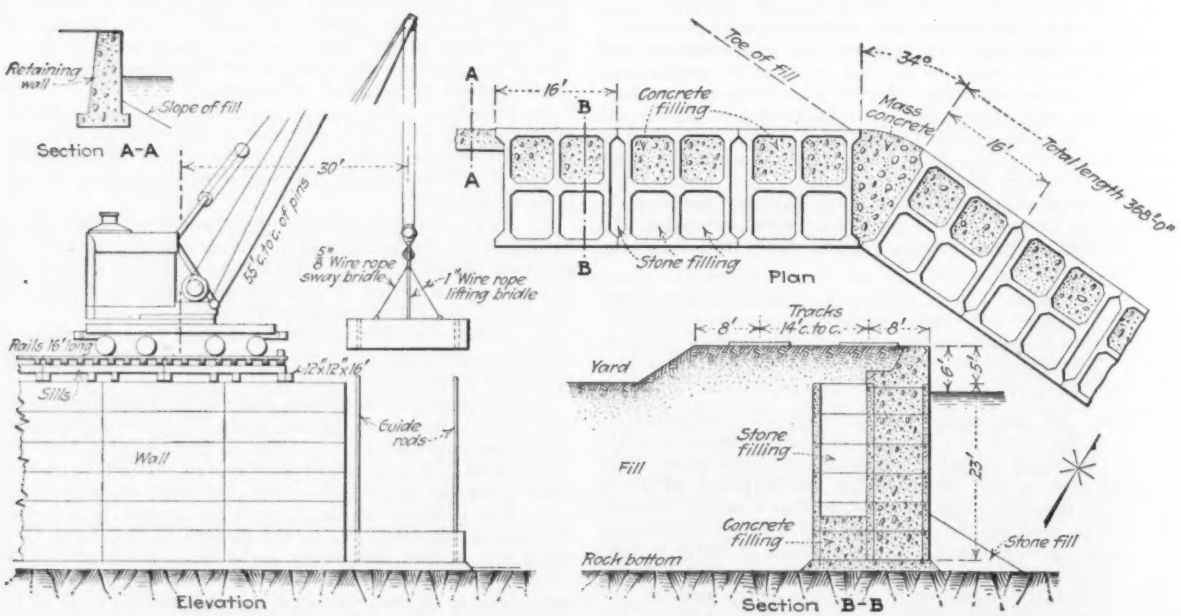


FIG. 1. DOCK WALL BUILT UP OF HOLLOW CONCRETE BLOCKS

a yard and railway trackage. At the west or inner end the upper part of the fill has a mass concrete retaining wall with a maximum depth of 12 ft. 9 in., but beyond this the concrete wall provides 23 ft. of water for vessels.

From the rock bed of the bay the wall is built up of concrete blocks to about a foot above the water line and is capped with 5 ft. of mass concrete, making a total height of 28 ft. to wharf level. This concrete and secured temporarily by four 2½-in. vertical tie-rods which are grouted into holes drilled in the rock, these rods engaging cored holes in the corners of the blocks. At one point the wall makes a change in direction and the triangular space thus formed is filled with mass 1:2:4 concrete which is bonded to the wall by the flanges or projections on the face of the blocks. About 200 blocks were required and were made by the cement company at its yards, using a 1:2:4 mix with 1¼-in.

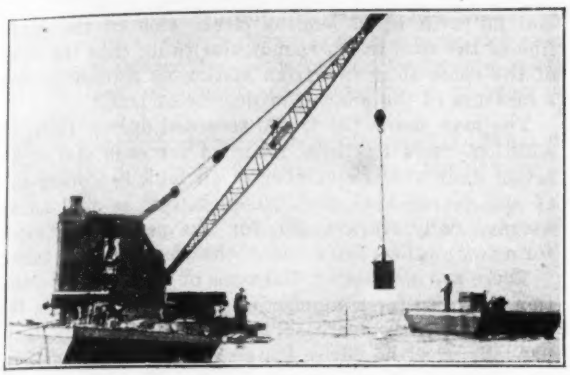


FIG. 4. DEPOSITING CONCRETE UNDER WATER BY DROP-BOTTOM BUCKET

stone for coarse aggregate. The concrete was poured in wood molds and left for three days, after which the blocks were removed and stacked for thirty days to cure before being used. Each contains about 9 cu.yd. of concrete and has a weight of 36,000 lb. in air or 21,000 lb. in water. Blocks stored in the casting yard are shown in Fig. 2.

A 25-ton locomotive crane placed the blocks, which were delivered in rear of the crane on flat cars. A short length of frame trestle was built to carry the crane while building the first section of the wall. Beyond that, the crane track was laid on the completed part of the work. Sills 12 x 12-in. and 15 ft. long, were laid across the wall to carry packed stringers of the same size, upon which the track ties were placed. This track was built in 16-ft. sections as the wall progressed.

Before a section of the block wall was commenced the bottom was cleaned by a small sand-sucker or hydraulic dredge, the nozzle of the suction pipe being handled by a diver. The diver also removed loose rocks, attaching a sling or grapple of the crane to rocks and boulders too large for him to move. The crane then picked up a concrete block from a car in the rear and lowered it into place, guided by the four rods. Stones were placed by the diver to level up the block on the sloping rock bed. The concreting train was then pushed out by a yard locomotive and the mixer, of 13 cu.ft. capacity, delivered concrete to a 27-cu.ft. closed drop-bottom bucket which the crane lowered into the water, so that the concrete was deposited quietly and directly in place to fill the pockets of the block. This concrete flowed under the block, filling all irregularities of the rock surface and the spaces between the stones used in leveling up the block. A 1:3:6 mix of stiff consistency was used for this filling. Fig. 3 shows the concreting train and the dredge scow. Fig. 4 shows the floating crane handling the drop-bottom bucket. On the scow at the right is the compressor supplying air to the diver who guides the bucket into position.

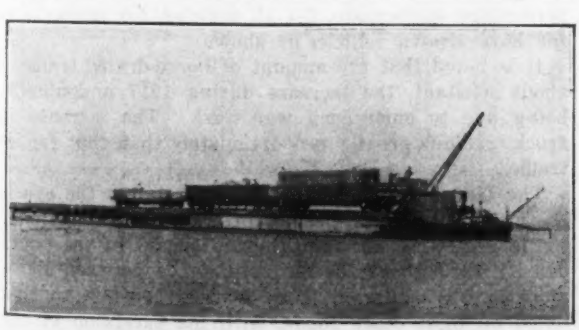


FIG. 3. CONCRETING TRAIN ON DOCK WALL

This sealing or anchoring concrete was allowed to set for 48 hours, after which additional blocks were placed to the full height of the wall. Concrete filling was then completed in the front pockets and 2½-in. stone was placed in the rear pockets by a grab bucket, the stone being run out on flat cars. Following the construction of the wall, the fill behind it was made with earth and loose rock obtained in stripping a quarry of the cement company, this fill being deposited by 16-yd. side-dump cars.

In building the 400-ft. length only one section of wall was damaged owing to a storm, and in that case the storm came up so suddenly as to prevent concreting the blocks in place. Since the bottom block was not disturbed, only the displaced upper blocks were removed and the section of wall was then reconstructed. Part of the concrete wharf has been in service for three years and during two winters heavy ice and high waves were experienced, but it is reported that no damage was done although timber piers in the same district suffered severely. It is expected to complete the work this season. This structure was designed and constructed under the direction of the J. C. Buckbee Co., Chicago, as engineers for the Petoskey Portland Cement Co.

Highway Problems in Britain

(London Correspondence)

British authorities on raising revenue for road maintenance are divided into two camps. There are those who assert that road charges should be raised from the land, since it is in the interests of local authorities to provide and maintain good roads so as to encourage road transport; and there are those who maintain that the tax now imposed on mechanical vehicles using the roads should contribute to their maintenance.

The total cost of maintaining British highways is £52,000,000 per annum, of which £9,000,000 have been raised in tax from 871,000 vehicles (motor driven). Under present legislation every motor omnibus contributes 6/10d. in direct taxation for every mile run, while automobiles contribute 3/4d.

According to Sir Henry Maybury, of the Ministry of Transport, 79 per cent of the population of the British Isles lives in urban districts, compared with 72 per cent 30 years ago. Nearly half the total population has gravitated to the large and relatively dense areas where traffic problems already present the acutest difficulties. This movement has led to the formation of joint town-planning committees in the north of England regions. The aim of these committees is to urge upon local authorities the necessity for prescribing such building lines as will create a dignified and roomy setting for the highways under the new road program; in these highways the width between fences varies from 100 to 120 ft. These committees will endeavor to secure road width, leaving for future determination the exact apportionment of that width between carriageways, footways and tracks reserved for special forms of traffic.

Traffic on Maryland's Roads Shown on Map

Graphic Explanation Afforded by Plotting Figures of Four-Year Count—Intensity and Seasonal Variation Given

By A. N. Johnson
Dean, Engineering College, University of Maryland

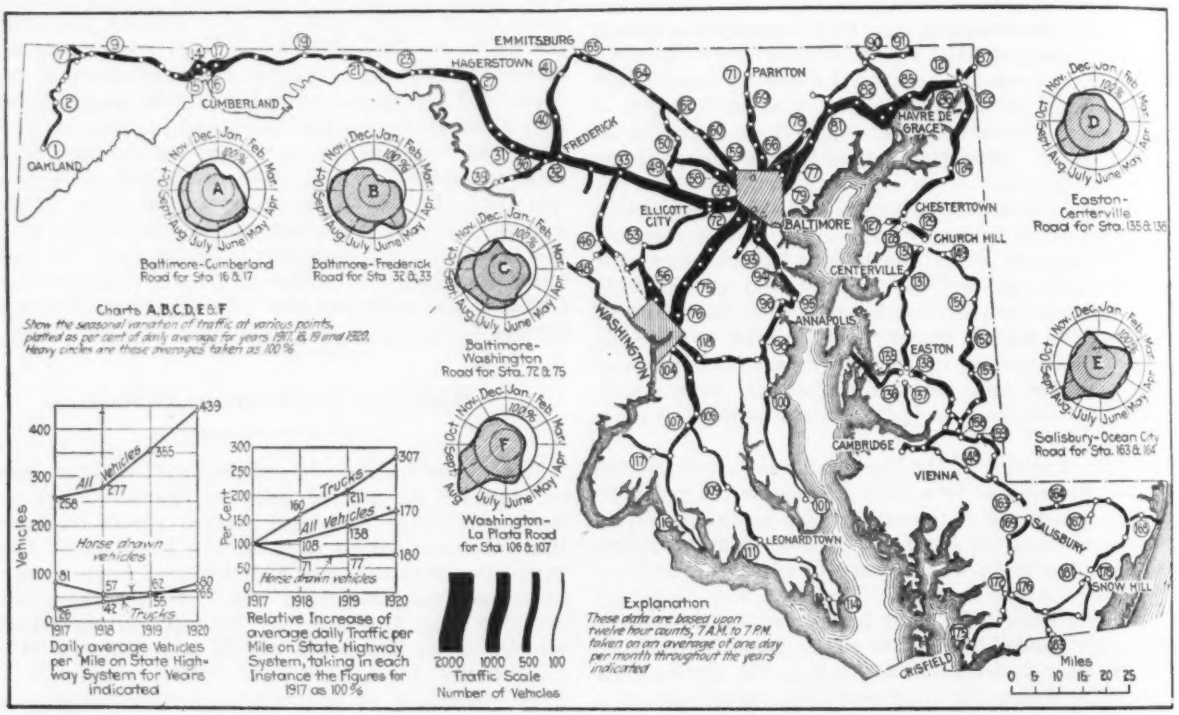
A TRAFFIC map visualizes, as can be done in no other way, the relative amounts of traffic that flow over different portions of a highway. There is here presented a traffic map for nearly the entire state highway system of Maryland, based upon traffic counts extending over several years.

This map was prepared at the Engineering Experiment Station of the University of Maryland, in cooperation with the U. S. Bureau of Public Roads and the State Roads Commission. The traffic counts were taken by the State Roads Commission of Maryland, under the direction of J. N. Mackall, chairman and chief engineer. These counts, which were made one day per month from 7 a.m. to 7 p.m., extended over the years 1917 to 1920, inclusive. The location of the counting stations is shown by small circles upon the map.

The basis upon which all the data are compared is the average daily traffic for a year. This quantity was obtained for a given station by platting the daily counts, with days for abscissas and the number of vehicles as ordinates. The area under these curves, as found by a planimeter, divided by the number of days (365) gave the average daily traffic for a year for a particular station. The values of the average daily traffic so found for each station were platted to an arbitrary scale upon a road map. These values were laid off with equal lengths either side of the center line of the road and perpendicular to it; thus the width of the space so drawn from station to station becomes a measure of the amount of density of traffic.

The map shows the traffic recorded during 1920. In addition, there has been recorded for each station the actual daily average number of all vehicles during each of the years—1917 to 1920, inclusive, as well as the average daily truck traffic for like periods. [Results for a few stations are given in the accompanying table.]

There are also shown diagrams of the seasonal variation in traffic for a number of stations and others that show the yearly increase in the average daily traffic per mile over the entire state road system. These latter diagrams were computed by platting the average daily traffic at the various stations as ordinates and miles as abscissas. The area between this curve and the horizontal axis, as determined by a planimeter, divided by the distance in miles, gave the average daily traffic per mile throughout the entire highway system for a given year. The actual increase in the daily average number of vehicles per mile, as well as the percentage of increase, for all vehicles, for trucks, and for horse-drawn vehicles is shown.


EMMITSBURG
HAGERSTOWN
CUMBERLAND
OAKLAND
FREDERICK
PARKTON
HAVRE DE GRACE
ELLICOTT CITY
BALTIMORE
CHESTERTOWN
CHURCH HILL
CENTERVILLE
ANNAPOLIS
EASTON
WASHINGTON
CAMBRIDGE
VIENNA
SALISBURY
LEONARDTOWN
SNOW HILL
CRISFIELD
Baltimore-Cumberland Road for Sta. 16 & 17
Baltimore-Frederick Road for Sta. 32 & 33
Baltimore-Washington Road for Sta. 72 & 75
Washington-La Plata Road for Sta. 106 & 107
Easton-Centerville Road for Sta. 135 & 136
Salisbury-Ocean City Road for Sta. 163 & 164
Charts A, B, C, D, E & F
Show the seasonal variation of traffic at various points, plotted as per cent of daily average for years 1917, 18, 19 and 1920. Heavy circles are these averages taken as 100%
All Vehicles
Horse drawn vehicles
Trucks
Vehicles
Daily average Vehicles per Mile on State Highway System for Years indicated
Per Cent
Relative Increase of average daily Traffic per Mile on State Highway System, taking in each Instance the Figures for 1917 as 100%
Explanation
These data are based upon twelve hour counts, 7 A.M. to 7 P.M. taken on an average of one day per month throughout the years indicated
2000 1000 500 100
Traffic Scale
Number of Vehicles
Miles
0 5 10 15 20 25

DISTRIBUTION OF TRAFFIC ON MARYLAND'S STATE HIGHWAY SYSTEM, BASED ON DAILY AVERAGES

It is noted that the amount of horse-drawn traffic is about constant, the increase during 1917 undoubtedly being due to emergency war work. The increase in truck traffic is greater proportionately than that for all traffic.

The feature of the map that first strikes the eye is the great increase in density of traffic as we approach the larger cities, although the uniformity of the traffic density throughout the entire distance between Baltimore and Washington is in marked contrast to that noted on most other roads, with the exception of the one running west from Baltimore to Frederick.

As our highway expenditures become heavier and the operation of a state highway system a more and more complex problem, the traffic census becomes a necessity for any intelligent study and guide in handling the situation.

How much use do we make of our roads? What do we pay per unit of road service? Given the number of service units, on what character of road is the service most economically rendered? These are but illustrations of a few of the important questions that can only be answered by the aid of a comprehensive traffic census. And a traffic map is a visualized traffic census.

TRAFFIC RECORDED AT CERTAIN STATIONS ON MARYLAND HIGHWAY SYSTEM

Station No.	1917		1918		1919		1920	
	Total	Trucks	Total	Trucks	Total	Trucks	Total	Trucks
1	226	25	290	36	166	24	206	51
2	170	7	145	10	146	15	217	61
7	145	8	222	27	181	11	334	27
	454	35	478	78	477	59	640	69
14	425	62	....	....	....	....	763	165
15	790	102	....	....	....	....	1,041	305
16	381	44	433	61	469	78	516	95
17	234	21	333	51	430	51	480	75
19	84	6	134	17	154	15	279	21
26	555	33	575	113	762	178	830	178
27	798	109	550	94	633	87	692	108
31	833	26	547	49	629	39	758	61
32	716	68	621	71	858	99	709	100
33	413	45	453	58	397	65	619	124
35	1,245	265	910	241	871	279	1,188	418
36	331	36	400	40	471	53	285	83
39	246	11	....	....	328	36	114	48
41	256	21	251	14	253	29	348	42
46	257	22	228	35	368	48	470	63
49	151	24	160	20	309	37	413	56
50	....	....	163	29	321	53	282	56
56	....	....	766	158	910	173	1,508	306
58	....	....	456	113	470	125	812	177
59	....	....	638	157	582	104	....	....
60	....	....	444	94	361	77	514	123
64	168	17	197	23	278	32	197	41
65	....	....	....	....	261	17	539	55
66	....	....	....	....	....	....	783	286
71	....	....	181	21	303	58	262	57
72	824	149	985	286	952	263	1,106	298
75	721	50	....	....	730	116	766	136
76	....	....	....	....	....	....	1,173	238
77	1,465	319	1,766	606	....	....	....	....
78	....	....	....	....	309	79	307	73
79	1,389	403	1,749	600	1,252	417	2,207	804
81	410	57	589	148	661	121	782	181
82	562	46	843	177	760	135	884	204
85	....	....	347	80	388	63	436	90
86	436	26	365	84	....	....	541	130
87	....	....	226	43	363	91	462	89
90	201	9	242	16	420	36	344	55
93	394	72	396	108	569	174	816	321
94	557	107	384	71	550	90	645	236
96	....	....	688	81	421	58	517	117
98	221	13	225	22	292	32	375	62
100	....	....	289	24	223	20	327	34
101	....	....	....	....	87	50	105	16
102	....	....	642	143	480	95	772	338
103	....	....	....	....	727	259	715	281
104	333	70	....	....	568	166	563	156
107	517	32	318	55	460	96	431	74
109	154	13	163	16	203	47	250	46
111	345	17	....	....	463	95	333	36
114	190	21	158	13	201	20	243	29
116	157	4	230	27	293	43	236	26
118	160	20	177	9	203	27	521	60
121	....	....	....	....	185	28	259	43
122	....	....	....	....	389	53	447	64
123	....	....	....	....	915	127	680	106
126	....	....	258	12	276	18	298	25
127	....	....	205	11	262	36	287	59
128	425	21	488	17	467	34	505	30
134	....	....	171	28	229	66	200	32
135	....	....	551	43	510	55	414	45
136	....	....	....	....	439	48	415	46
137	423	21	291	41	371	46	387	58
138	....	....	294	17	415	40	561	28
146	377	26	432	47	419	47	384	52
148	102	6	108	5	155	18	135	14
149	....	....	138	9	204	21	191	17
158	183	11	219	18	253	26	230	33
163	233	23	218	23	293	41	303	48
167	....	....	57	2	56	5	68	4
168	203	15	257	24	287	21	295	32
169	290	22	323	30	385	39	495	56
172	....	....	....	....	247	36	323	54
175	240	8	237	8	297	28	450	52
176	173	9	217	21	....	....	246	36
177	175	19	179	12	192	16	282	30
183	....	....	148	6	209	12	236	28

Estimating Brickwork-Labor Cost

Every Reasonable Labor Detail Included in Compilation—Cost of Executing Individual Operations Given

By Chas. F. Dingman
Palmer, Massachusetts
(*Copyright 1922 by Chas. F. Dingman*)

THE method of figuring the cost of brickwork-labor herein described is one that I have been using with highly-satisfactory results. I realize that the ideal method would be similar to that for concrete costs presented by Taylor and Thompson in their book "Concrete Costs." Such a method, however, would involve the tabulation of such unit operations as picking the bricks from the pile, loading hods or wheelbarrows, delivering to scaffold, picking up, turning, placing, spreading mortar, cutting the joint, pointing, raising the line, plumbing corners and jambs, etc.

However, existing competitive business methods, as well as labor conditions, make the use of such details impracticable, although good business demands that the estimate closely approximate the actual cost.

If the estimator could determine the exact conditions under which the work is to be done he might be justified in using detailed methods of estimating. The best he can do, however, is to exercise good judgment in handling the work, and estimate accordingly.

Basis of Data—The quantities which are set down herein as a normal hourly production for different classes of work were determined after a careful study of all the published literature that I could find plus data secured from personal experience. Incidentally, these figures show how much weight should be given such press statements as: "Bricklayers in Chicago are now laying 2,000 bricks a day, and that is really only half a day's work."

While the bricklayer's wages may not always be the largest single item in the cost of laying bricks, the number of bricks each man lays per hour is usually the determining cost factor.

The following table gives the hourly production that may be expected from competent bricklayers working under average conditions:

TABLE I—AVERAGE PRODUCTION—COMMON BRICKWORK
Joints struck one side of walls

Thickness of Wall	Using Lime Mortar	Using Cement Mortar
3 ft. 0 in. or over	300	250
2 ft. 4 in. to 3 ft. 0 in.	250	225
1 ft. 8 in. to 2 ft. 0 in.	225	200
1 ft. 4 in.	200	175
1 ft. 0 in.	175	150
0 ft. 8 in.	150	125

If joints on both sides of the wall are struck the production will be about 10 per cent less than the figures given above.

TABLE II—AVERAGE PRODUCTION—FACE BRICKWORK

	Bricks per Hour
Running Bond, plain-cut joints	90
Running Bond, V-joints	70
Running Bond, raked-out joints	70
Running Bond, raked-out and struck smooth	65
Flemish Bond, plain-cut joints	65
Flemish Bond, V-joints	60
Flemish Bond, raked-out and struck smooth	50
Flemish Bond, rodded joints	45

Other special bonds will decrease the production, as will the introduction of pilasters, openings, paneling, etc.

Hints on Labor—The number of laborers or tenders required is determined by the number of bricks being laid, the distance the bricks must be moved, necessity of culling bricks, etc. The ratio may be anywhere from

four laborers to each five bricklayers to three laborers to one bricklayer. The following information will be helpful in determining the number of laborers necessary:

1—One mortar mixer, working nine hours, can produce about 4 cu.yd. of sand-cement or sand-lime-cement mortar.

2—One laborer in an hour can load about 1,120 bricks, wheel them 40 ft. using a barrow, and dump them on the scaffold. Using a hod, he can make more trips but will probably transport only half as many bricks.

3—One laborer can handle about 500 bricks per hour from car to wagon or from wagon to pile.

4—Two good laborers working together can handle about 16 lin.ft. of pole-staging per hour.

5—On thick walls one laborer can build, take down and move horse-scaffolding for twelve bricklayers. Thinner walls go up more quickly so more men are needed to build scaffolds. A fair ratio would be to decrease the number of bricklayers to each scaffold-man by two for each decrease of 8 in. in wall thickness below 3 ft. It is, of course, assumed that horse-scaffolding will not be used for any walls above normal story height. No figures are included here for patented scaffolds.

6—One laborer can cull from 200 to 300 bricks per hour, depending upon the quality of the bricks and the stringency of the inspection.

7—One laborer, using a barrow, can wheel about 33 cu.ft. of mortar 40 ft. an hour.

8—Two laborers, with a chain hod-elevator, can elevate 2,500 bricks 30 ft. an hour.

9—A two-barrow elevator, operated by a motor or steam engine, can elevate 10,000 bricks 30 ft. per hour.

10—A two-horse team will travel with an empty wagon about three miles per hour or about two miles per hour with the following loads:

On poor earth roads, 2,000 lb., equal to 370 average bricks
On fair earth roads, 2,500 lb., equal to 465 average bricks
On good earth roads, 4,000 lb., equal to 750 average bricks
On hard surface roads, 6,000 lb., equal to 1110 average bricks

Steep grades will reduce both the load and the speed of travel.

Other Information—Motor trucks can be figured to carry rated loadings at an average safe speed of 8 to 12 miles per hour. The same proportionate time must be allowed for loading and unloading as for horse-drawn wagons.

Actual production will vary very widely in different parts of the country with the figures set forth here. Every estimator will undoubtedly have his own data-book, covering the experience of his own organization. Those data will reflect the skill of the workmen as well as the organizing and executive ability of the foremen, superintendent, and higher officials. However, by substituting the proper quantities and taking due account of all local conditions, this method of estimating may be used for practically every job.

As a typical example, we may take the case of an ordinary brick mill building, four stories high, with interior brick walls enclosing the stairways. We will assume the building to be 80 ft. x 200 ft. and the thickness of the walls in inches as follows:

	Exterior	Interior
First story	20	16
Second story	16	12
Third story	16	12
Fourth story	12	12

Figuring the quantity of bricks by the usual method and deducting all openings we find that the job will require about 641,000 bricks distributed as follows:

164,000 in 20-in. walls on first story
29,000 in 16-in. walls on first story
139,000 in 16-in. walls on second story
139,000 in 16-in. walls on third story
22,000 in 12-in. walls on second story
22,000 in 12-in. walls on third story
126,000 in 12-in. walls on fourth story

It is assumed that sand, cement and lime have been purchased for delivery at the site, that the bricks must be hauled from the siding two miles away over good earth roads, and that teams are more readily available than motor trucks. It will also be assumed that the lime, cement, sand and bricks will be stocked about 25 ft. from the building and that a steam elevator will be used.

Hourly rates of pay are assumed as follows:

Bricklayers	90c.
Laborers	50c.
Teams	100c.
Elevator—Flat rate of $20 per day, including engineman, fuel, raising for additional stories, etc.	

Horse-scaffolding will be used throughout, working from the floor construction and the outside bricks will be laid over-hand.

Evidently the first thing to do is to get the bricks from the siding to the site. Since the team can haul 750 bricks to a load, and since a laborer can handle 500 bricks per hour from car to wagon, it will take two men about 45 minutes to load a wagon. If the driver helps to load, it will require only thirty minutes. The cost per trip is therefore:

Team—	
Loading time	30 min.
Traveling loaded at 2 m.p.h.	60 min.
Dumping	5 min.
Returning at 3 m.p.h.	40 min.
	135 min.
135 minutes @ $1 per hour	$2.25
Men—	
2 men, each 30 min., 60 min.	.50
Cost or 750 bricks	$2.75

This equals $3.67 per thousand net, so we will use a figure of $3.70 to allow for a few minor contingencies.

It is assumed that a sufficient number of teams will be employed to keep the men at the car busy; otherwise their waiting time must be included in the cost. In most places it will be found practicable to employ lower-priced men for unloading cars, and the figure above may be varied accordingly.

From the method given in *Engineering News-Record*, Feb. 23, p. 315, we find that about 266 cu.yd. of mortar will be required, to be used as follows:

86 cu.yd. on the first story
65 cu.yd. on the second story
65 cu.yd. on the third story
50 cu.yd. on the fourth story

Because a job of this size will hardly tax the full capacity of the elevator, the cost of hoisting need not be figured separately for each floor but can be covered by a single item. Where a building is very high or the number of bricklayers great enough to use the full capacity of the elevator, it is well to estimate the materials to be hoisted to the various heights and to figure accordingly.

From the dimensions of the building and the locations of the piles, it will be seen that the greatest horizontal distance that materials will be transported is about 305 ft. and the average about 165 ft.

Therefore, the total cost of making and delivering the mortar will be as follows:

Making 266 cu.yd. at 4 cu.yd. per 9 hr., 598.5 hr. @ 50c.	299.25
Transporting 266 cu.yd. (using barrows) average distance 165 ft. at 33 cu.ft. per hour for 40 ft. 897.7 hr. @ 50c.	448.85
Labor cost of mortar	$748.10

Figuring three scaffolds per floor (if we can work from the floor plank we shall only need two scaffolds per floor) above the first and two on the first floor, we find that we need 6,160 ft. of scaffolding which must be built, taken down and rebuilt rapidly enough to provide for the number of bricklayers employed. This job appears to require about 512 hours of scaffold builders' time, which at 50c. per hour equals $256.00

The cost of taking the bricks from the pile and transporting them, by barrows, to the scaffold, an average horizontal distance of 165 ft. at the rate of 10,120 bricks 40 ft. per hour, will be 2,361 hr., which at 50c. per hour equals $1,180.50

Laying the bricks will take, for 20 in. walls, $\frac{164,000}{200}$ = 820 hr.; for 16-in. walls, $\frac{307,000}{175}$ + 1,754 hr.; and for 12-in. walls $\frac{170,000}{150}$ = 1,133 hr.; a total of 3,707 hr. which at 90c. an hour is $3,336.30

Since the walls on this kind of a job must be pointed on both sides, the production will be decreased 10 per cent, which means that the number of hours must be increased by one-ninth, thus: pointing, 412 hr. at 90c. is 370.80

If the average force is to be fifteen bricklayers, the job will run for at least 36 working days, but, since allowance must be made for rainy days and other delays, a mason foreman will have to be on the job for at least 40 days, and his rate will be about $48 for a 5½-day week, or 7.3 weeks, which equals 350.40

Since all of the bricks above the first floor must be elevated, an elevator will be needed for 22 of the 31 working days, and this will cost, at $20 per day 440.00

We now have a total of $6,682.10

for the labor cost on the job (which is an average cost of $10.42 per thousand). To this must be added the cost of unloading and carting which, at $3.70 per thousand equals 2,371.70

(Of this amount approximately $448.70 is payroll and $1,923. is team hire).

To wash down the building, two bricklayers and two laborers will be required, each working 7 days of 8 hr. each, or a cost of 156.80

Labor Total $9,210.60

Compensation insurance, figured as 5% on payroll and 3% on team hire will be 422.07

$9,632.67

I have not attempted to discuss such items as cutting and grinding brick for arches, building quoins or ornamental cornices, though proper allowance must be made for each such item. However, it is almost impossible to set down figures that will be of any value without examining the design in each case. I usually allow at least ten minutes of bricklayer's time for each brick that must be cut and ground and ten minutes per running foot of each projecting course. These amounts I add to the total cost of doing the work.

Tri-City Activated-Sludge Plant at Pasadena

The proposed activated-sludge plant to be built jointly by Pasadena, South Pasadena and Alhambra, Cal., noted in *Engineering News-Record*, April 27, p. 709, is designed to have a capacity of 36 m.g.d. It will be located on the sewage farm which the City of Pasadena has operated for many years. The effluent from the new works will be used for irrigation, but it will be beyond the capacity of the present farm. It is proposed to sell the surplus to ranchers, thus conserving for domestic purposes the water that these ranchers are now using for irrigation. The plan is to dewater the sludge to about 70 to 80 per cent moisture and then to use it without further treatment for local fertilizing purposes. Experience at the existing sewage farm, states R. V. Orbison, city manager and city engineer of South Pasadena, and formerly city engineer of Pasadena, in a letter to *Engineering News-Record*, shows that a large quantity of sludge can be successfully handled by spreading it on the ground and plowing it under. The cost of the tri-city works will be proportioned between the several municipalities, probably on the basis of the number of acres served in each city, Mr. Orbison states. Pasadena has already voted bonds for its share in the cost of building the activated-sludge plant. In June it is expected that Alhambra will vote on bonds for its share of the sewage-works and for a construction of sewers. South Pasadena expects to vote on bonds for its share in the activated-sludge plant before long.

Los Angeles Mapped from Air to Aid Traffic Studies

Area of 6½ Square Miles in Business District Covered by 450 Exposures at Total Cost of $1,625

By C. H. Richards
Associate, Engineering Offices, J. B. Lippincott, Consulting Engineers, Los Angeles, Cal.

LOS ANGELES is the hub of a large mileage of paved roads that radiate in many directions. These roads and the all-year-around motoring climate that California enjoys, together with the rapid increase in population of Southern California towns and cities, have resulted in an acute congestion of traffic in the streets in Los Angeles.

The Automobile Club of Southern California, which has 65,000 members, is helping to solve these problems. The club has had a survey made to ascertain whether substantial portions of the traffic congesting the business section of the city could be diverted therefrom by improving broad streets around its perimeter. An extended count showed that a small percentage only could be so by-passed and that relief could be had by remedying conditions in the business area itself.

Topographical features have compelled the city to grow mostly to the southwest, with the result that the business area is long and narrow with few cross outlets, thus forcing traffic to a few streets. Several months ago the Automobile Club instructed this office to make an intensive study of traffic conditions, report its findings and recommend steps to be taken for relief of the congestion.

It was decided that an aerial map, if made in conjunction with a traffic census, would furnish the best basis for this study. Co-operation by several of the city departments in preliminary studies lead to the adoption of this aerial survey for a strip of the city 4.5 miles long and 1.33 miles wide, or approximately 6.5 square miles. At the time the picture was taken, a "flow check" was made. This was to determine the speed of vehicles and street cars traversing the area.

There was also a count made at numerous corners to ascertain the quantity and direction of all automobile and street car movement. On the aerial map itself the total number of vehicles within a given area could be counted. The number of machines parked on streets could also be ascertained from this count. With all of this information a definite relation, synchronous in character, was established between the total number of vehicles within an area and their rate of flow and number passing certain corner in a given time.

Detail Shown—The map is of sufficient detail so that a count could be made of automobiles parked in open-air parking places, such as vacant lots, roofs of buildings, etc. From a count of these machines and adding the automobiles stored for the day in garages, an estimate of the addition to the normal street traffic can be made which will approximate the number of vehicles that the outlets of the congested district will be called upon to pass during the peak hours of traffic flow.

The airplane used in making the survey was equipped with an Eastman, 20-in. lens camera, and flew at a height of 4,000 ft. The mosaic is at a scale of 186 ft. to the inch. This scale will allow for contraction in the finished prints or reproductions, which are to be 200 ft.

to the inch. This scale will permit using tracings of city maps to copy improvement features, if so desired.

Pedestrians on the pavements could be counted where not in shaded portions of the picture. Street car and railroad tracks show plainly.

Results Secured—The most important results gained from the picture were suggestions for elimination of awkward angles and turns at various street intersections and the possibilities afforded for cutting through new connecting streets along the least improved routes. Study of the map brought out ideas and facts that ordinary tables, diagrams and line maps would not readily do.

The aerial map presents the features so realistically

AERIAL MAP SHOWS TRAFFIC ON CITY STREETS

that explanations are not needed when suggesting a project of improvement for consideration. Projected improvements can be delineated in water colors upon the picture and if changes are to be made, these colors can be eradicated readily. Lantern slides can be made of any area under discussion and these slides used at conferences where the improvement is the subject of debate. In this way the projects can be presented in a popular way.

It is found that estimates can be made readily from this aerial map, as all improvements can be scaled from it. The only field information needed is the height, class of building, etc.

Specifications—Following are the specifications for the aerial map submitted for bids to the firms doing this class of work:

(1) Area to be surveyed: The area to be surveyed shall be that portion of the City of Los Angeles, Cal., bounded as follows: ————

(2) Day of making survey: The survey shall be mad on either the first Saturday or the first Monday followin the signing of this contract, weather permitting. It shal not be made upon any other day unless authorization there for is given by the Automobile Club.

(3) Time of making survey: The survey shall be mad at the time of day when the rays of the sun's light are a nearly vertical as possible and the shadows are shortest i both the major and minor axis of the picture.

(4) Scale: The original mosaic or master map shal be on a scale of 200 ft. to 1 in. (The original negative mad in the air shall be exposed at said scale of 200 ft. to 1 in and no enlargement of said negative shall be made in con structing the mosaic or master map, except as ordinaril required in the general rectification processes, which it i understood and agreed between the parties hereto sha in no case exceed a 2 per cent change of scale of said orig inal negative.)

(5) Accuracy: The original mosaic or master map sha be as accurate as possible and there shall be no variation o error therein greater than 5/10 of 1 per cent in any are where there are street intersections, or greater than 1 pe cent in any other area.

(6) Clearness of picture: Vehicular traffic on unshade portions must stand out clearly enough so that individua vehicles can be counted without the use of a magnifyin glass. Shadows shown in the picture must be sufficientl transparent so that vehicles can be counted with the ai of a magnifying glass with a power of not ove four diameters.

(7) Quality of work: The mosaic or master map shall be built up from the individual pictures taken in the survey with such workmanship as will insure a reproduction that will not show lines of joining and will be free from other imperfections.

(8) Disposal of mosaic or master map: The company shall retain the ownership of all negatives secured or used in the making of the survey and also the original mosaic or master map. The company shall immediately after the delivery of the prints hereinafter provided for, deliver to the Automobile Club the original mosaic or master map for its use for a period of one year from the date of such delivery. Such mosaic shall be mounted on composition board.

(9) Prints: The company shall furnish to the Automobile Club one print of the original mosaic or master map on velvet surface paper and one on glossy surface paper, each print to be mounted on linen or on composition board at the option of the Automobile Club.

The Automobile Club shall be entitled to additional copies of the picture at a cost of the labor and material used in making such prints, plus 25 per cent thereof. With such mosaic the company shall furnish a schedule of the time of each photographic exposure used in the preparation thereof.

(10) Copyright and reproductions: The company shall copyright the completed picture secured by this survey and shall retain the copyright and shall not sell, give away or produce reproductions of said picture for one year except on written authorization of the Automobile Club.

(11) The work called for herein: The original mosaic or master map and the prints will be made subject to acceptance thereof by the Automobile Club, which acceptance will be given in writing only upon the receipt by the said Automobile Club of a written statement signed by its consulting engineer and the chief engineer of the Board of Public Utilities of the City of Los Angeles, that the said original mosaic or master map has been by them compared with the actual measurements of the distance existing between street intersections in the area to be surveyed and has been found to conform to the limits of accuracy hereinbefore set forth and with the requirements hereof as to the clearness thereof. Such verification shall be promptly secured by Automobile Club without expense to company.

(12) Liability for accident or damage: The company hereby waives any claim against the Automobile Club for damages arising out of the performance by the company of any of the terms of this contract and hereby expressly agrees with the said Automobile Club that it will protect, save and keep harmless the said Automobile Club from any claim for damage or injuries sustained or alleged to have been sustained by anyone on account of the performance of the terms of this contract by the company, its agents, employees or sub-contractors.

Cost—The pictures were taken Feb. 3, 1922, between the hours of 11:30 a.m. and 1:30 p.m. There were 450

exposures on 7- x 9-in. film. Approximately 47 per cent of each print was used in building up the mosaic map. The Automobile Club secured insurance against property damage of $1,500 and $10,000 to $20,000 for personal liability, the premium being $222 per year. The cost of the maps to the Automobile Club was $1,625 for the 6½ sq. miles, or $250 per square mile, not including insurance.

The contract for this map was let to the Pioneer Aerial Engineering Co. of Beverly Hills, Cal; this company specializes in aerial map work.

Results obtained in this work lead to the conclusion that aerial maps, if made upon a sufficiently large scale, will show sufficient data to aid materially in the solution of traffic problems at a lesser cost than other mediums.

Buckle-Plate Longitudinal Joint For Concrete Roads

New Jersey Adopts Twenty-Foot Slab Separated at the Center and Having Dowels at All Transverse Joints

A 20-FOOT slab uniformly 8 in. thick, heavily reinforced and having a keyed longitudinal joint and doweled transverse joints has been adopted as standard for concrete roads in New Jersey. This design is a development of a similar construction which was employed last year and which proved reasonably easy to obtain with ordinary contracting skill and workmanship. Incidentally very few cracks have developed in the jointed pavements built in 1921. The design shown

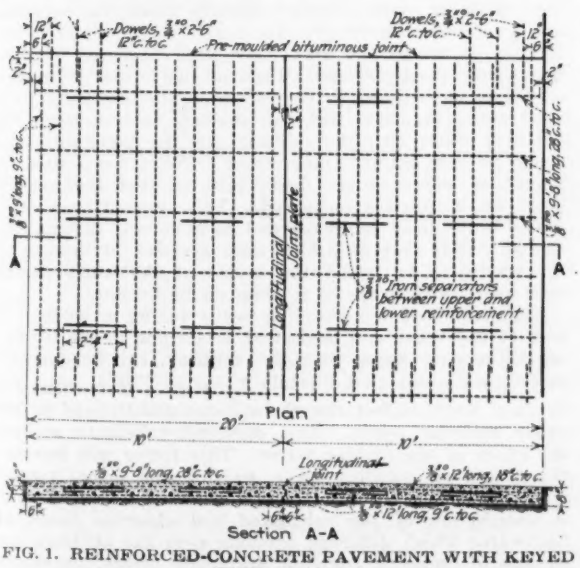


FIG. 1. REINFORCED-CONCRETE PAVEMENT WITH KEYED CENTER JOINT

is for heavy traffic roads. Other sections have a single layer of reinforcement or are plain concrete.

A slab, Fig. 1, of uniform thickness on a crowned subgrade is employed. To insure the required curve of the subgrade, surfacing with a subgrader is specified. Forms are required to be set ahead for the subgrader and the soil is required to be consolidated with a 10-ton roller before it is planed to profile. Similarly exact construction is called for throughout the fabrication of the pavement.

Two layers of reinforcement are required for the heavy traffic pavement shown by Fig. 1. Where single reinforcement is required, the top layer of rods shown by Fig. 1 is omitted. Two things are to be noted in the reinforcing; it is a separate structure between transverse joints for each half of the slab and where two layers are employed they are held apart vertically by stiff iron separators or spreaders. The distinguishing structural detail is, however, the longitudinal joint, Fig. 2.

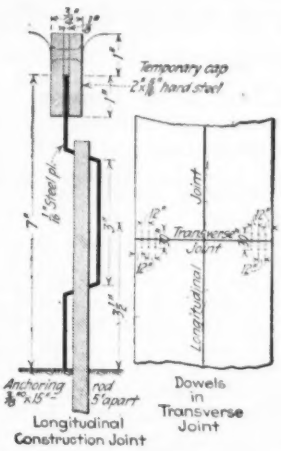


FIG. 2. LONGITUDINAL JOINT DETAIL AND DOWEL ARRANGEMENT

A sheet-steel buckle-plate, with its top 1 in. below the slab surface forms the joint. It is lined up vertically and pinned to the sub-grade. Also it has a removable cap set onto its top edge to form the ¾-in. groove which is tooled and, after the cap is pulled out, is filled with bitumen. The buckle-section of the joint sheet, it will be noted, forms a keyed joint. This is a development from the flat-plate joint used in 1921. It locks the inside corners wherever a transverse joint crosses the longitudinal joint and the dowels can, as shown, be confined to the outside corners. In 1921 construction the dowels were placed 2 ft. apart across the pavement. On one side of the joint the dowel rods are wrapped in two layers of tar paper or are encased in a paper tube so that the rods will slide as the joint opens and closes.

Concrete proportions for pavement are usually 1:1½:3 or 1:2:4 but are changed, when the aggregates are unusual, to the figures required to ensure use of the specified volume of cement per cubic yard. Similarly the slump limit specified for consistency of mixture, is determined for each aggregate. Concrete is required to be mixed 1½ minutes.

T. J. Wasser is state highway engineer of New Jersey with E. A. Reed as assistant in charge of design and C. F. Bedwell as construction engineer.

Mileage and Costs of California Highways

By the end of the present fiscal year California will have completed about 3,007 miles of its state highway program, according to a recent announcement of the California highway commission. The total mileage in the road system on which the state highway commission has charge of both construction and maintenance is about 6,300 miles. There are in the state about 70,000 miles of dedicated public roads outside the boundaries of incorporated cities. Of this total more than 6,000 miles have been paved by state and county agencies. The mileage of paved surface is being rapidly increased by the extensive road construction and improvement projects now under way. The California state highway commission alone will this year expend about $15,000,000 in new highway construction. During 1921 the average cost per mile for the different types of road were roughly as follows: Graded roads, $12,000; bituminized macadam, $21,000; concrete base, $30,000 and bituminous pavement, $24,000.

Preventing Loss of Power Due To High Backwater

Notes on Design and Tests of the Thurlow Backwater Suppressor To Offset Head Reduction

Abstract of a paper read before the annual convention of the American Society of Mechanical Engineers, Atlanta, Ga.

By J. A. Sirnit

Designing and Electrical Engineer, Alabama Power Co., Birmingham, Ala.

IN MANY hydraulic power plants, there is a great loss of power due to the fact that during flood conditions, when water is being wasted over the spillway, the level of the water in the tailrace at the outlets of the draft tubes leading from the turbine is raised, thus reducing the head on the turbines and in turn their capacity and the output of the power plant. In many cases of proposed developments, engineers have hesitated in recommending the carrying out of the development on account of backwater conditions in the tailrace, which can be foreseen and predicted very closely.

Engineers for many years have wrestled with this problem and have tried to overcome this difficulty by installing a greater number of generating units where it is possible to do so, to compensate for the loss in capacity of each unit; of course, such a procedure necessarily makes the installation more expensive with the resulting increase of

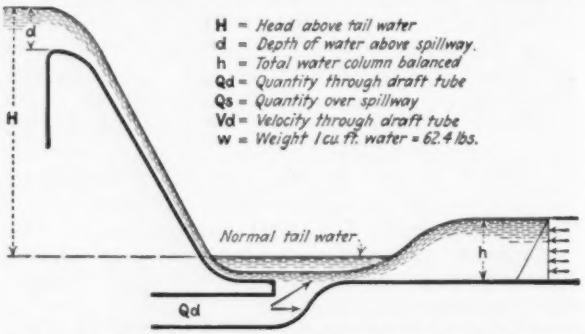

H = Head above tail water
d = Depth of water above spillway.
h = Total water column balanced
Qd = Quantity through draft tube
Qs = Quantity over spillway
Vd = Velocity through draft tube
w = Weight 1 cu. ft. water = 62.4 lbs.
d
H
Normal tail water
h
Qd

FIG. 1. ACTION OF THE STANDING WAVE IN REDUCING TAILWATER

production costs. Attempts have also been made to counteract this loss in head by admitting into the draft tube water through jets at a relatively high velocity which, by accelerating the velocity of the combined turbine discharge and jet water through the draft tube, produce a negative head which is added to the head on the turbine. A number of variations in the place and manner of introducing this jet into the draft tube have been tried and results published but the results have not been entirely satisfactory.

The most logical and simplest way to maintain the normal head on the waterwheel and thereby the full capacity of the plant during flood periods is to remove the high tailwater from the discharge opening, and credit is due to O. G. Thurlow, chief engineer, Alabama Power Co., who conceived the idea of utilizing the waste water to accomplish this fact, thereby successfully solving the problem. The development of this conception resulted in what is now known as the "Thurlow Backwater Suppressor."

It is a well known phenomenon of nature that water flowing over a masonry dam, having a downstream face of ogee section, leaves the apron in a thin sheet at high velocity. At a point below the dam, the water rises turbulently, forming a so-called "standing wave," "hydraulic jump," or "back roll." The thickness of this sheet and the velocity of the water depends upon the height and shape of the downstream face of the dam, upon the depth of water at the crest of the dam, and upon the quantity of water flowing over the dam. The energy developed in this thin sheet of water has generally been regarded heretofore as solely of destructive nature, but in the backwater supressor the energy of the spillway water is directed so as to remove the backwater from over the draft-tube orifice, sweeping it downstream, thus freeing the draft tube from this pressure of water over it and maintaining a practically uniform head on the turbine as long as the spillway water is able to sweep the backwater away from the draft-tube orifices. In Fig. 1 is shown diagrammatically the action of the overflow spillway water

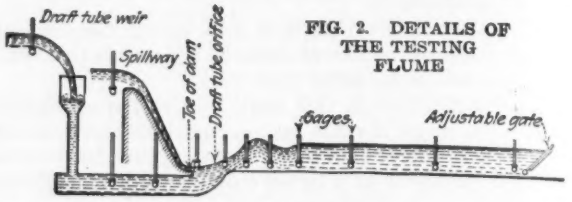


FIG. 2. DETAILS OF THE TESTING FLUME

on the tailwater. It is indicated there, that the energy of the spillway water not only removes the height of tailwater from the draft-tube orifice but even lowers the normal tailwater level to a level that can be predetermined.

Testing Models — In order to substantiate the idea and evolve a definite theory on which to base the calculations, a model was constructed on ¼ scale, where a small flow at 8 ft. head was available. The results obtained here were so interesting that, to check the data obtained and to increase the accuracy of measurements, a second and larger model was constructed to ⅛ scale, where a greater flow and head were available. The results obtained with the two models, when reduced to the same scale, were in close agreement and the observed results followed those calculated for similar conditions.

Fig. 2 shows diagrammatically the essential elements of those models. Each consists of a forebay for stilling the water, a spillway having the usual ogee section, a draft tube with its orifice located directly under the spillway and a tailwater wasteway. The height of the water in the forebay wasteway and draft tube were measured in glass gages conveniently located on central platforms. By means of these, measurements corresponding to the pond level head above the river bed, the effective turbine head, the depth of water over the spillway and the backwater head could be conveniently determined. Weirs were used in admitting water to the draft tube so that the amount could be accurately measured. This amount was ordinarily maintained to correspond to a normal turbine discharge. Bear trap stop logs were provided at the end of the wasteway by which the height of the water in the wasteway could be varied to simulate backwater.

The height of the standing wave taking a section of unit (1 ft.) width and neglecting losses due to the friction of the moving water over the spillway, can be approximated by the empirical formula $h = \sqrt{d^3 \times H^3}$ in which d is depth of water in feet over the spillway and H, head in feet above spillway apron. This does not take into account the effect of the turbine water. This factor will increase the height of standing wave, so that the actual results will be somewhat better than as shown by this formula. A comparison of the calculated and observed heads of backwater which different amounts over the spillway are capable of removing from the draft tube orifice, are shown in the accompanying table. These figures are for a section of backwater 20 per cent greater in width than the spillway $h = \sqrt{0.83\, d^3 \times H^3}$.

CALCULATED AND OBSERVED HEADS OF BACKWATER

	MODEL 1			MODEL 2	
d	h Observed	h Calculated	d	h Observed	h Calculated
(In.)	(In.)	(In.)	(Ft.)	(Ft.)	(Ft.)
4	6.00	6.5	0.25	0.40	0.59
5	7.75	8.05	0.75	0.84	0.88
6	8.75	8.9	1.00	1.30	1.20
7	9.75	10.0	1.25	1.51	1.56
7.5	11.00	10.6	1.50	1.72	1.78
			1.75	2.10	2.08
				2.48	2.35

These readings are illustrated in Fig. 3 which shows curves of the turbine head with and without the suppressor

and is typical of the performance of the backwater suppressor with a normal thickness of water over the spillway and varying heads of backwater.

The effect of the turbine head of different amounts of water over the spillway is shown by the curve in Fig. 4. It is noted that very small amounts cause a decrease in head because sufficient velocity has not been given to the draft-tube water to cause a thinning of the sheet over the draft-tube orifice, but when the ratio of spillway to draft-tube water increases to about one to one the curves take a decided course upward and reaches its peak and starts falling off again due to a greater quantity of water passing over the orifice with practically no increase in velocity above that of the point of maximum head. This curve does not represent the best performance possible but it is typical of the ideal theoretical curve which is shown in the figure.

The curve in Fig. 5 shows the over-all performances of the test as compared to that without the suppressor. It will be noticed that the head drops off slightly as the backwater increases, due to a greater quantity of water necessary to hold the standing wave, until a point is reached where the standing wave is 13.26 in. high, and the curve takes a sharp curve down. This point represents the critical stage or the maximum height of backwater capable of being suppressed by given amount of spillway water, this could be increased by having a design of spillway permitting a greater discharge.

Following the curve on down it will be seen that a substantial increase in head is obtained even after this point is reached. The last point plotted is

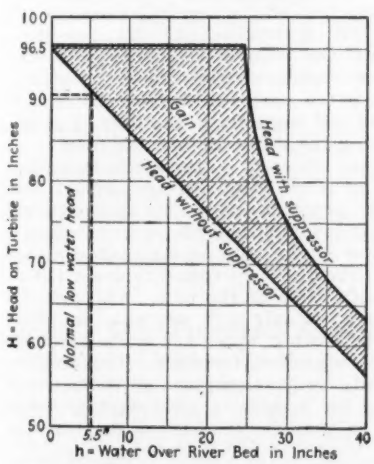


FIG. 3. PERFORMANCE CURVE FOR MODEL 2

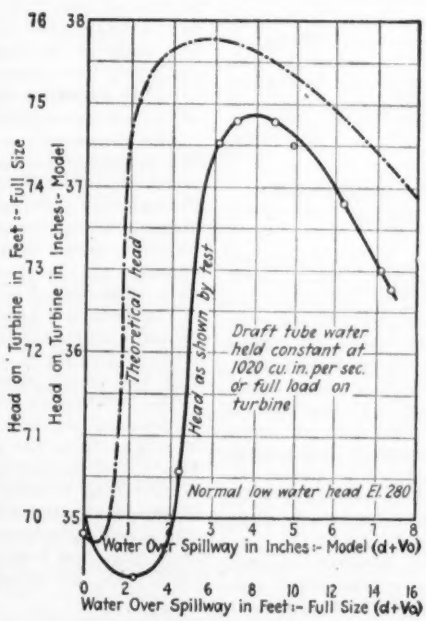

Head on Turbine in Feet :- Full Size
Head on Turbine in Inches :- Model
Theoretical head
Head as shown by test
Draft tube water held constant at 1020 cu. in. per sec. or full load on turbine
Normal low water head El. 280
Water Over Spillway in Inches :- Model (d+Vo)
Water Over Spillway in Feet :- Full Size (d+Vo)

FIG. 4. HEAD CURVE FOR MODEL 1

heads varying from 30 to 100 ft. The amount of water flowing over the spillway will cause this length to change but for depths up to 15 ft. this range will hold good.

The distance out of point x is determined by the amount of water passing through the draft tube. The area of the draft-tube orifice subject to the action of the sheet of spillway water must be proportioned so that a back pressure in the draft tube is not necessary to force the two waters to mix. The curve R_1 is great enough so that the centrifugal force of the fast moving sheet of water will not cause it to leap clear of the concrete surface. R_2 makes a smooth transition connecting point x and R_3 and is about $\frac{1}{2}$ R_1.

The standing wave is held out just beyond tangent R_3. The total distance from the lip of spillway apron to the point of wave must not be greater than good design of the other features will permit as the friction of the high velocity water diminishes the height of the standing wave thereby causing a greater amount of waste water necessary to operate.

The river channel below tangent R_3 must be finished with neat concrete for a distance of 4 heights of the standing wave, in the case of heads up to 25 ft., and 5 to 6 heights for heads varying from 30 to 100 ft. This is necessary for good performance although a rough bed of water pocket can be used but a great waste of water is required and heavy undercurrents, due to an imperfect standing wave, might scour the river bed badly or undermine the protecting apron.

This is of great importance if the rock strata is poor as open seams will allow the high static pressure beyond the wave to be transmitted back under the protecting apron causing an uplift. This uplift must be given attention even when the apron is carried out to the desired

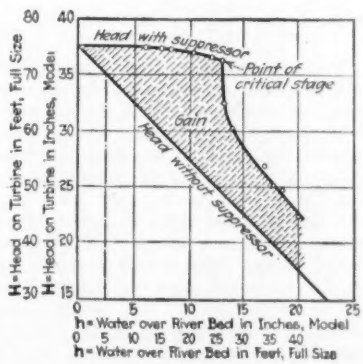

Head with suppressor
Point of critical stage
Gain
Head without suppressor
H = Head on Turbine in Feet, Full Size
H = Head on Turbine in Inches, Model
h = Water over River Bed in Inches, Model
h = Water over River Bed in Feet, Full Size

FIG. 5. PERFORMANCE CURVE FOR MODEL 1

with backwater 50% of the total head and an increase of 5 in. is recorded.

Design of Draft-Tube Orifice — Several shapes of draft tube orifices were tested, the one shown in Fig. 6 leaves very little to be improved upon for getting a maximum height of standing wave and a maximum head on turbine. This design can be modified to give a greater head on turbine but does so at a sacrifice in height of standing wave.

The location of point X is of great importance as it controls the increase in head on turbine and its relation to the elevation and angle of discharge of the spillway apron must be very exact or a poor performance will result, also consideration for the turbine "runoff" during the period when the suppressor is not in action must be kept in mind.

The length of tangent t must be such that it will direct the spillway water well along the line ab and should be at least 5 ft. for heads up to 25 ft. and 7 to 10 ft. for point and provision made for its secure anchor.

Dividing Walls—Each unit must be provided with dividing walls to permit the water from coming in on the side and to allow any one unit to operate independently.

The correct height and length of these walls is determined by the backwater and discharge curves of the river at the location of the power house. Section A-A, Fig. 6, shows the condition for the installation of four units. The three intermediate walls are at an elevation shown by the backwater curve when the required amount of water to operate four turbines and three suppressors is passing that point. When the fourth suppressor is brought into action the condition is as shown by the dotted line in unit No. 2 and these walls simply act as a guide to hold better conditions at the point of wave and prevent surging.

The two outer walls are designed for extreme flood conditions, as any water passing over the walls into the suppressor sheet will cause a loss in head on the turbine and in height of standing wave; however, if there should

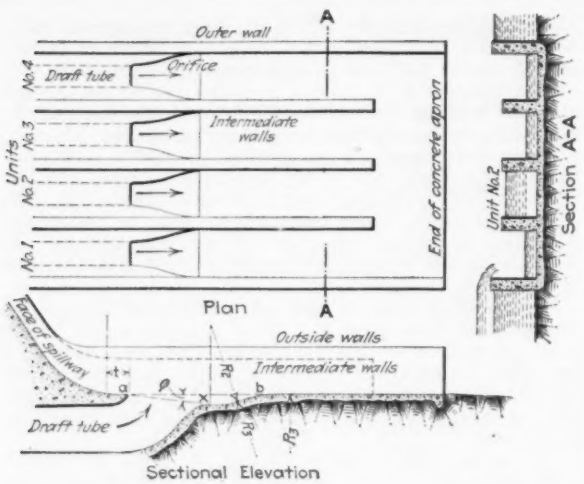


FIG. 6. TYPICAL LAYOUT OF DRAFT-TUBE ORIFICE

be spillway gates on both sides of the power house section equal to the width of two units it need not be at the maximum high water elevation but at the stage shown by the combined discharge passing the power house and side spillway. This is due to the fact that although a perfect standing wave is not formed at the toe of the side spillways a lower elevation is created than will be farther downstream where the true backwater elevation is measured.

Application of Backwater Suppressor to the Coosa River Plant

Further extracts from the preceding paper by John A. Sirnit, outlining the design of the Mitchell plant of the Alabama Power Co., in which the Thurlow backwater suppressor is used.

BEING satisfied that the backwater suppressor will perform as indicated by the tests, the next logical question would be: will the suppressor type power plant cost more to build than the conventional type of equal capabilities, and if so, how much more. If the cost is higher than a plant of conventional design with an equal output, or even if the cost were the same in both cases, the conventional type of power plant would be preferred, because in a new and untried design there always will be found things that may not work out as predicted, while the conventional type plant has proved its worth.

The estimates for the Mitchell plant, however, showed that not only the cost of the suppressor type plant was not higher than a conventional type plant of equal output but it showed even lower cost for the same number of units in each case, which of course meant that for given output the suppressor type plant was considerably lower in cost.

The design finally evolved shows several radical changes and represents an entire departure from the established conventional design of hydro-electric power plants. Fig. 1 shows the general plan of this particular development and Fig. 2 the cross section through the power house section. The salient points of interest, especially those departing from time honored practice, are many, but only the more important ones shall be outlined.

The principal and most outstanding feature in this plant is the location of the power units on separate foundations in river on the upstream side of the dam. Although this is not necessarily the only possible way to build the power house, in this particular instance it was the most economical. The river at this point being comparatively narrow, the entire length of the dam was required for spillway, and since the prime requisite of this type of plant is that the draft tube discharge directly under the spillway section, the units were so located that they would not obstruct any part of the spillway section.

The individual and separate power house units offer the added advantage that trash racks do not present a solid front, which helps materially in cleaning them and affords an easy and convenient way of diverting the trash past the power house and over the spillway.

The usual power house building is entirely eliminated; the generator room is covered with a low roof, which is designed in two sections, joined on the tranverse line, mounted on rollers; each section moving in opposite direction. In normal operation the generator room is completely protected from weather, but if access is required for handling only part of the machinery, this roof can be opened and all parts are handled through that opening with the crane.

A single gantry crane with full travel over the entire length of power house section is so designed that everything, with exception of spillway gates, can be handled with this crane, and is equipped with one 125-ton and one 20-ton hook, the former for handling heavy machinery and the latter for raising and lowering penstock gates, handling racks, stop logs and all other lighter parts.

The entire operating floor is on one floor level: generators, governors, switchboard, low tension switches, bus galleries and offices, and are easily reached without climbing of stairs or bidders. This materially adds to the convenience of operators and makes the supervision and inspection of the plant more effective. It should be mentioned that this feature of providing easy accessibility to all important parts of the station is very frequently lost sight of by the designer and the lack of these conveniences have been the cause of inefficient operation or even breakdowns due to the fact that operators have neglected the equipment in lesser or greater degree.

The generators are so installed that the hot air from the generator is discharged into a separate compartment under the main floor and is expelled into the atmosphere through side openings of that room in summer time, thereby keeping the generator room reasonably cool. In winter, however, when heat in the rooms is desired the outside openings can be closed and registers in the floor of generator room opened letting the warm air into the room.

The penstock does not represent a true scroll casing but rather a combination of scroll effect and open flume. The water velocities in the penstock being low, approximately 4 ft. per second, this combination afforded a better design.

The location of power house units on the upstream face of the dam lengthened the discharge tunnel to about 120 ft. in length from the center line of the unit. Although the velocity of the discharge is only 4 ft. per sec., the effect of this long column of moving water had to be carefully investigated and offered a problem for study. This problem was solved satisfactorily by increasing the governor action to 3½ sec. and setting the turbine to the lowest practical level. At this point it shall be emphasized that turbine

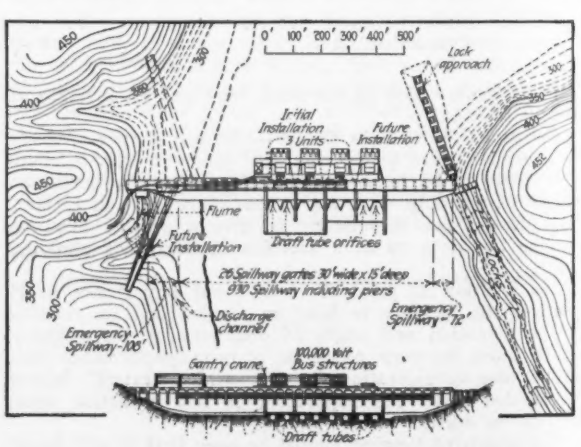


FIG. 1. GENERAL LAYOUT OF MITCHELL POWER PLANT ON THE COOSA RIVER

settings always shall be as low as possible, especially where improved draft tubes are employed. Many of the troubles in existing power plants, such as pitting of runners, excessive vibration, etc., can be directly traced to high wheel settings particularly with high specific speed runners.

Twenty-six spillway gates of the Tainter type are provided, each 15 ft. high and 30 ft. wide; these gates are capable of passing the maximum flood water known to have existed in the past. There are also 6 bays, 20 on the east and 4 on the west end of the dam, which are designated as emergency spillway openings. The crest of these openings is level with the top of the spillway gates and their function is to provide additional spillway capacity in case of unprecedented floods when water would rise above normal pool level.

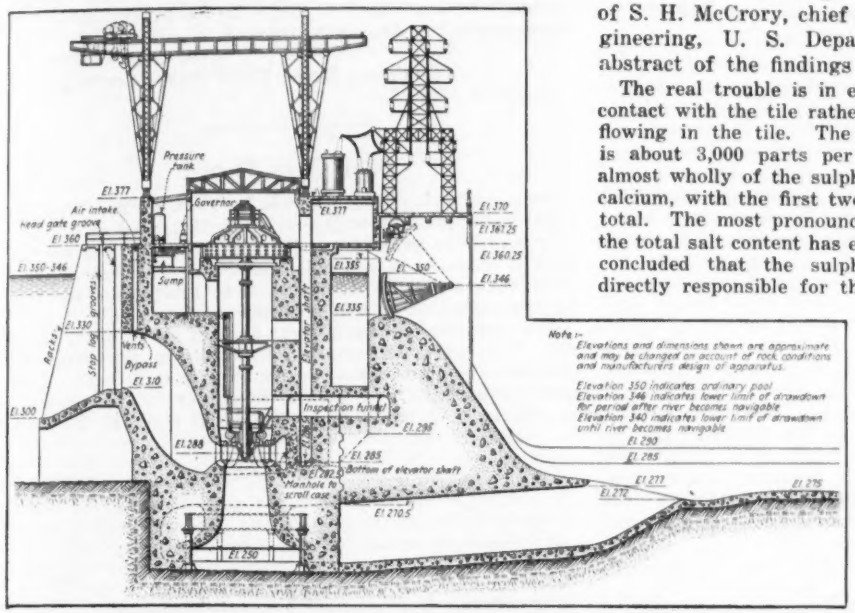


FIG. 2. SECTION THROUGH POWER HOUSE

Concrete Drain Tile in Alkaline Soil

Limits to the use of concrete tile in alkaline soil are indicated by a report of investigations made in southwestern Minnesota by the State Department of Drainage and Waters in co-operation with the U. S. Department of Agriculture. This report was made by Dalton G. Miller, senior drainage engineer, under the direction of S. H. McCrory, chief of division of agricultural engineering, U. S. Department of Agriculture. An abstract of the findings of the report is given below.

The real trouble is in extreme conditions of the soil in contact with the tile rather than the salt content of water flowing in the tile. The danger limit of the soil water is about 3,000 parts per million when the salts consist almost wholly of the sulphates of magnesium, sodium and calcium, with the first two near 66 to 75 per cent of the total. The most pronounced failures have occurred where the total salt content has exceeded 4,500 parts. It has been concluded that the sulphates are in a large measure directly responsible for the failure.

Characteristic failures are by disintegration beginning with a checking and cracking of the exterior surface of the tile wall, followed by an increase in volume. Finally all binding principles of the cement disappear and the mass resembles a freshly-mixed batch of lime-mortar concrete. Of the exact chemical processes much remains to be learned, but the final result in extreme cases is a loss of most of the cement. There is no known solution for the problem but betterment in quality of the tile will minimize the difficulty in that the danger limit of the sulphate waters can be raised considerably. Until it is possible to make concrete that will definitely resist all action of sulphate waters, concrete tile should not be considered where soil analyses indicate sulphates in more than nominal quantities.

Except where disintegration has resulted from the action of sulphates, concrete tile are giving satisfactory service throughout the area covered by the investigation. Physical tests indicate that the general quality of concrete tile manufactured in southwestern Minnesota during 1919 and 1920 was high enough to meet the requirements of the drain-tile specifications of the American Society for Testing Materials. Tile manufactured previous to 1919 was somewhat inferior in quality to that now being made.

To secure better concrete tile the following suggestions are made: (1) Use only properly graded clean sand that is free from organic matter; (2) more coarse aggregate; (3) more attention to the consistency of the mix, which means a wetter mix at nearly all the plants; (4) more care to regulate the time of mixing so that there is more uniformity with respect to different batches and also to insure that each batch is thoroughly mixed; (5) curing the product before it leaves the tile plant. Attention is directed to the almost negligible quantity of aggregate retained on the ¼-in. screen. As this material represents the only course aggregate it is evident that these tile should properly be called "mortar tile" rather than "concrete tile." There is no indication that any of the mixing waters used are objectionable.

OUTSTANDING FEATURES OF PLANT

Power units on separate foundations upstream of dam.

Power house building eliminated; roof over units instead.

Outdoor gantry cranes control entire plant.

Backwater suppressor takes care of flood conditions.

Federal Land Purchases To Protect Navigation

Purchases of land by the National Forest Reservation Commission for the protection of navigable streams totaled 1,602,906 acres to June 30, 1921, at an average cost of $5.31 per acre and at a total cost of $8,505,755, according to the latest annual report of the commission to the secretary of war (Senate Document 90). The distribution of this land by states and other related figures are given in the accompanying table.

PURCHASE AREAS, AREAS APPROVED AND AREAS ACQUIRED FOR BY NATIONAL FOREST CONSERVATION COMMISSION TO JUNE 30, 1921.

	Total Purchase Area	Approved For Purchase			Acquired		
	Acres	Acres	Price	Value	Acres	Price	Value
Me.	121,503	32,320	$5.52	$178,280	32,143	$5.51	$177,038
N. H.	828,611	413,678	6.56	2,712,159	383,110	6.70	2,565,466
Md.	80,259						
Va.	1,032,154	445,208	3.69	1,641,563	350,361	3.54	1,241,682
W. Va.	845,365	128,253	3.17	403,307	99,110	3.31	327,681
N. C.	2,143,235	334,400	6.17	2,064,769	301,706	6.17	1,862,971
S. C.	151,866	18,454	5.43	100,210	18,454	5.43	100,210
Ga.	558,247	152,763	6.66	1,018,087	134,094	6.64	890,799
Ala.	196,520	68,995	4.60	317,600	47,127	4.59	216,256
Tenn.	1,134,991	265,146	4.86	1,288,009	213,424	4.89	1,043,182
Ark.	1,469,906	48,295	3.55	171,511	23,377	3.44	80,469
Grand Total	8,562,657	1,907,512	$5.19	$9,895,496	$1,602,906	$5.31	$8,505,755

* Averages and corresponding value have been changed to the nearest unit, which may cause some slight discrepancies in the corresponding grand totals when compared with additions of the figures above them.

LETTERS TO THE EDITOR

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Slabs for Column Bases Hard to Get

Sir—Referring to your April 27 issue, page 684, the article by Eugene W. Stern on "Multiple Steel Slabs for Large Column Bases": If our experience in the last few years is any criterion, the idea proposed, while theoretically ideal, does not work out to good advantage in practice.

For a few years we have used steel plates in this manner but invariably receive a protest from the fabricator because of the difficulty he experiences in securing thick steel plates. These steel base plates are the first pieces to be shipped and put in place, and it takes the longest to secure them from the mill. A great many engineers, on the strength of such a recommendation as shown in this article, would go ahead and design their bases using heavy steel plates, and after the plans were all drawn up, contracts let, and details made, would run up against the difficulty of getting these heavy steel plates in time to avoid delay in erection. We had just this difficulty on a building we put up last year at one of our plants. The order for the steel slabs was the first to be placed, the mill order for the first-tier columns being placed a week or so later. The columns were received from the mill, fabricated and shipped before the steel slabs were received by the fabricator. We were delayed at least three weeks in starting to erect our steelwork, waiting for the steel slabs.

Hereafter we are going to use either cast-steel slabs or the usual cast-iron bases.

N. H. MCKENZIE,
Engineering Department,
Chicago, May 11. Corn Products Refining Company.

In Favor of 1: 50,000 Scale for Maps

Sir—The letter of F. A. Noetzli in your issue of May 11, p. 801, expresses a point of view which should receive greater publicity at a time when there appears to be a popular feeling that the scale of the topographic maps of the U. S. Geological Survey should be changed from 1: 62,500 to 1: 63,360. One has but to compare the present use of the metric system in America with that of ten years ago to realize that we are gradually adopting that system, and that it is hardly reasonable now to go to large expense and the inconvenience of being afflicted with two scales for the same type of map, only to go through the same inconvenience and expense a few years later when the disadvantage of the 63,360 scale becomes more apparent.

Mr. Noetzli suggests a scale of either 1: 50,000 or 1: 100,000. The latter is too small a scale for this type of map, but there appears to be every reason for the adoption of 1: 50,000 and every reason for caution in the use of any scale with a more intricate relationship between distance on the map and distance on the ground.

The scale of 1: 62,500 has few reasons for existence outside of the fact that the majority of our maps are already drawn to that scale. The scale of 1: 63,360 has the apparent advantage at the present time of giving us an exact relationship of 1 in. = 1 mile. The increased accuracy of the inch-to-the-mile scale over that now in use is too small to warrant the expense and inconvenience of the change, the difference between the two scales being only 0.014 in. in 1 mile or about 0.1 in. in 10 miles. For general use this difference is immaterial.

The scale of 1: 50,000, which is uniformly in use in continental Europe, has much to commend it. It is admirably adapted to the metric system and will be continually increasing in value as the metric system becomes more generally used. It will give us a slightly larger scale for our maps, which is desirable. It fits admirably with the scale of 1: 500,000 now being used for the state maps and the 1: 1,000,000 scale of the map of the world. Its relationship with the scales 1: 125,000 and 1: 250,000 already used for mapping a very considerable part of the country is simple and these scales would not require changing.

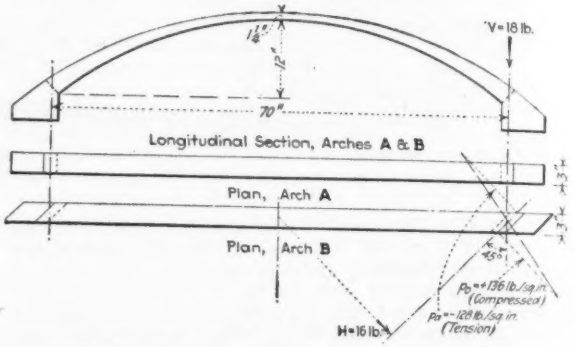
A final reason for the 50,000 scale, and an important one in view of the fact that the inch will continue to be used as a unit of measurement for some time to come, is the relationship of 1 mile = 1.267 in., or for all practical purposes 1¼ in. In addition to being the ideal metric scale, it is nearly as convenient to use with our present system of measurements as the scale proposed.

GEO. C. DANFORTH,
Chief Engineer, Maine Water Power Commission.
Augusta, May 23.

Skew Arch Thrust

Sir: Referring to the article by Prof. C. T. Morris entitled "Thrust of Skew Barrel Arch Measured on Laboratory Model" in your issue of April 20, 1922: The Fischer method of analysis, which is adopted by Professor Morris, gives absurd results when applied to a structure which is narrow compared with the length.

For example, assume a right arch of 70 in. span, 12 in. rise, 3 in. width of roadway, 1¼-in. crown thickness, and otherwise similar to the Morris experimental arch. This arch, or arch *A*, will have a weight of 36 lb. above the skewbacks, and analyzed by the usual methods the horizontal thrust due to the dead load of the rib would be 22.5 lb., and the thrust tangential to the axis of the arch rib would be 27.5 lb. Assume a second arch, *B*, with the same rise, the same width of roadway and the same distance between centers of skewbacks as for arch *A*, but with the abutments skewed to an angle of 45 degrees. This second arch is about equivalent to a vertical slice 3 in. wide cut off of one face of the Morris arch; it will have abutments 4.24 in. long and the span on the square will be 49.5 in., measured from center to center of skewbacks. Arch *B* will be stable; hence the vertical component of the total thrust tangential to the axis of the arch rib falls within the abutment.



SKEW AND SQUARE ARCHES COMPARED

Now apply the Fischer theory to find the magnitude and point of application of the resultant of the total horizontal thrust, which Fischer assumes must be normal to the abutment, and which Prof. Morris says will be equal to the thrust of a right arch of equal (projected) area. On this theory the total horizontal thrust normal to the abutment would be 16 lb. for arch *B*, and by the formula $e = (s/2) \cot \phi$ the distance of the resultant from the center of the abutment is 24.75 in. The unit stresses at the skewbacks by the formula $p = (H/b)(1 \pm 6e/b)$ are $p = 3.774 (1 \pm 35) = 136$ or -128, that is, 136 lb. per square inch compression at the obtuse corner of the arch and 128 lb. per square inch tension at the acute corner of the arch.

Stated a little differently, the Fischer formula gives a horizontal resultant of 16 lb. located six abutment lengths away from the center of the abutment, and this 16 lb. causes compression stresses on one portion of the abutment

ranging from zero to 136 lb. per square inch and aggregating a total of 148 lb.; and on the other portion of the abutment tension stresses ranging from zero to 128 lb. per square inch and aggregating a total of 132 lb.

In general the stresses transmitted to the abutments of an arch all result from the application of vertical forces within the space bounded by vertical planes through the arch faces and the skewbacks. While one may conceive forces as called for by the Fischer formula being applied at the ends of arch *B*, it is difficult to believe that vertical forces aggregating 36 lb. (the weight of the arch), and of necessity transmitting their effect through the arch rib, can produce any such effect.

The resultant thrust of an arch is that force which applied to the abutment would in effect replace the arch. At its point of application any force may be resolved into components. With the vertical component of the resultant known to fall within the abutment, how can the horizontal component lie six abutment lengths away? There must be a horizontal component along the abutment, as well as the one normal to it, which latter is the only one considered by Dr. Fischer.

In the *Beton und Eisen* article Dr. Fischer states that the triangles which lie between the skew arch and its circumscribing right arch are to be taken as "gewichts- und widerstandslos"; that is as without weight or resistance. In an arch such as the Morris arch the Fischer resultant thrust would have to be transmitted by a medium incapable of resistance, which is a manifest absurdity.

In his article Professor Morris does not give complete dimensions of the experimental arch, nor dimensions showing the locations of the six springs supporting the movable abutment. Also, he does not give the stresses registered by the springs; it is only the *changes* in the spring stresses caused by adding load which are plotted on the small-scale diagrams. The author states that after the level sand fill 3 in. deep over the crown was placed "the abutments were leveled and brought into proper position" and that this was called "zero-load" condition. It is hoped that Professor Morris will supplement his article by giving the spring stresses which were developed under zero-load condition, and further information as to how the proper position of the movable abutment for zero load was determined.

New York, May 18, 1922. DANIEL ROYSE.

The High Cost of Tardy Engineering

Sir—As a sequel to the article by Chas. P. Dunn, in *Engineering News-Record*, April 27, p. 699, entitled "Graphics Applied to Economic Location of Building," the writer considers the following discussion timely.

Sites for industrial development are frequently purchased without more than a superficial examination. Large sums of money are invested in these sites without regard to their adaptability to the construction requirements of the project and not until after the purchase has been consummated are engineers employed to determine the topographical, geological, or hydrographical fitness of the site.

In many instances, this procedure is dictated by a misconceived policy of secrecy. Such a policy is a natural but mistaken expression of the true principles of economy, being adopted to prevent the raising of prices and other steps that would increase cost to the purchaser. But this often results in unreasonably excessive construction cost. Options may be obtained to secure the purchase price against increase pending proper investigation by an engineer. Should the site, as a result of such investigation prove unsuitable, the option may be surrendered and the loss entailed thereby, together with the cost of the engineer's investigation, will be insignificant as compared with the additional expense frequently incurred because of lack of proper and timely information.

In one case, which has come to the personal attention of the writer, a site was purchased and construction of the project practically completed when conditions developed which necessitated the expenditure of several times the amount of money originally estimated. These conditions could, and should, have been pre-determined. Their effect could then have been easily foreseen and, other requirements being on a par, a more suitable site selected.

In this instance, the site lay on the bank of a river that is widely respected for its vagaries of current and other peculiarities. Construction plans for the project included a railroad embankment located within about 100 ft. of the river edge. The site had been immune from erosion, according to the best authorities, for a period of more than twenty years and no consideration was given to the possibility of its recurrence. Construction had hardly been completed, however, when erosion set in necessitating the expenditure of more than twice the cost of the plant itself.

While immediate steps were taken to check this erosion, it was not until two years after the plant had been placed in operation that borings were made to determine geological conditions underlying the site. These borings indicated a surface stratum, 20 to 25 ft. thick, of alluvial clay. Beneath this, extending from mean low water level to below the bottom of the river bed, lay a stratum of sand varying in thickness between 60 and 80 feet. A conclusion is that the superimposed weight of the railroad embankment together with erosion, due to sub-surface currents in the river, caused the sand stratum to disintegrate with consequent sloughing of the surface stratum of clay.

To offset the erosion it was necessary to revet the entire shore line of this property with a willow mat 110 x 2,800 ft. At wartime costs of labor and material, it can easily be seen that the expenditure of many times the actual cost of a proper investigation by an engineer would have been justified in order to pre-determine the practicability of this site.

Another case within the personal knowledge of the writer involved the purchase of an extensive and costly tract fronting the same river on its southern reaches. Upon this site it was proposed to construct an industrial plant having, as its most important unit, a dock, or quay, extending along the shore line about 1,400 ft and projecting into the river far enough to provide a suitable depth of channel, at extreme low-water stage, for ocean-going vessels. This site was inspected, superficially, during a stage of water very nearly approaching flood-stage. Purchase of the property was consummated before any surveys were made to determine hydrography of the river bed or any other investigation made to determine sub-surface conditions.

Fortunately, in this instance, before definite plans were made for construction, topographic and hydrographic surveys were made. These surveys developed the fact that at a stage of about 5 ft. above mean low water, there existed a reef which projected into the river from the bluff bank a distance of about 250 yards. This reef extended along the entire river frontage of the site. Thus, proper investigation disproved an entirely favorable impression, created by a superficial examination. The estimates for the dock suffered an immediate and extensive revision—upward. The property, however, had already been purchased at great cost and, to date, is undeveloped.

These two instances, the most outstanding of the writer's experience, cost a corporation hundreds of thousands of dollars, whereas preliminary investigations, together with the cost of forfeited options, would have cost about one per cent of the actual loss sustained. Other engineers undoubtedly have knowledge of many similar instances, all of which demonstrate the need for consultation and employment of engineers at the very inception of any construction project. It is a field in which they are pre-eminently serviceable but one in which their services are given but little consideration.

Mr. Dunn, in the article above referred to, develops his "cost contours," in planning the economical location of a building, from a topographic map prepared in advance. If of proved economy in determining the location of a single building, it follows that such advance information is of proportionately greater value in planning the layout of an extensive industrial enterprise, or other project requiring the economic grouping of a number of buildings.

In marked contrast to the usefulness of a topographic map, soil borings, etc., which should constitute the engineer's activity in the preliminary phase of a project, is the low cost at which such information can be obtained.

St. Louis, Mo., May 6. T. T. CRESSWELL.

NEWS OF THE WEEK

New York, June 8, 1922

Warren Brothers Co. Loses Paving Suit

U. S. District Court in Los Angeles Holds Fresno Work Does Not Infringe

In the U. S. District Court at Los Angeles, Cal., May 29, Judge Benjamin F. Bledsoe handed down a decision in favor of Fresno County and Thompson Bros., contractors, in an action instituted by Warren Bros., Co., of Boston, charging infringement of the Warrenite-Bitulithic paving patents. The type of paving laid by the county under specifications designated as type A and drafted by Chris P. Jensen, county engineer, the court ruled, does not infringe the Warren patent. By the decision it is estimated that Fresno County, for work already completed or contemplated, is saved payment of $200,000 in royalties. The work on which infringement claims were based included half a block of roadway on Blackstone Ave.

The case involved the validity of the so-called Wallace patents, under which the Warren Co. has been operating since the expiration in 1920 of the basic Bitulithic patent No. 727,505. (The status of the Warren patents was discussed in detail in an article in *Engineering News-Record* of Dec. 15, 1921, p. 969.)

The Fresno case came to trial Nov. 8 in Los Angeles. Prior to the trial of that case the Warren company had filed suit against the California Construction Co. and the Federal Construction Co., other contractors who had used the specifications referred to. The county intervened and secured injunctions against further proceedings in the cases pending decision in the Thompson case.

THE COURT'S DECISION

This is the first time that the Wallace patents have been the subject of litigation. In its decision, the court said in part:

"I am persuaded from all of the facts involved, including an inspection of pavement produced by the defendant, that the two courses of pavement produced by them were and are not blended within the meaning of the term as used in the plaintiff's patents. In my judgment, therefore, there is no infringement of plaintiff's patents shown by the product of defendant. The specifications do not infringe the first claim of the patents.

"The real contention of plaintiff seems to be that its patent is infringed if an upper course of pavement be laid upon a lower course of same while the lower course is in a hot or plastic condition, irrespective of whether it is rolled immediately or not. In view of prior art the court cannot conclude that the plaintiff is entitled to have its patents thus construed because patent No. 727,505 issued to Warren in 1903 and which expired before the defendant's structure was produced, indicated the laying of a bituminous composition of any desired nature upon an under course and the rolling of this while yet soft. This contributes to the art, in the judgment of the court, and negatives now the broad claim which the plaintiff seeks to have injected into his patent. The usual decree of dismissal will be entered."

Highway Bill Deadlock Broken

(Washington Correspondence)

The deadlock on the highway bill finally was broken on June 3 when conferees for the Senate and for the House of Representatives compromised their differences in regard to that legislation. The Senate conferees agreed to accept an authorization for an appropriation rather than a direct appropriation of funds, while the House conferees, in turn, agreed to an increase in the limit of cost per mile.

As agreed to in conference the expenditure of $50,000,000 for federal-aid highways was authorized for the fiscal year which will end June 30, 1923; $65,000,000 for the fiscal year which will end June 30, 1924 and $75,000,000 for the fiscal year ending June 30, 1925.

Federal aid is limited to $16,250 per mile during the fiscal year to end June 30, 1923 and to $15,000 thereafter.

Under the agreement reached in conference, $6,500,000 is authorized for forest roads and trails during both the fiscal years of 1924 and of 1925, instead of 1924 only, as is provided in the House bill. The House provision relating to the re-allotment of funds in the event that approved projects are not put under contract within one year from date of approval.

Cement Case Retrial Soon

Following a conference in Washington June 6 between Attorney General Daugherty and Col. William Hayward, U. S. Attorney for the Southern District of New York, a retrial of the criminal case against the cement manufacturers of the eastern district was decided on as soon as a presiding judge can be assigned. The first trial ended in a jury disagreement (*Engineering News-Record*, June 1, p. 925). Decision was also reached to begin the trial of the Midwest group of cement makers on June 15.

Labor Board Orders Wage Cut for Railroad Shopmen

A wage cut of 7 cents per hour for railroad mechanics and 9 cents for freight carmen, effective July 1, has been ordered by the U. S. Railroad Labor Board. This cut will affect about 400,000 employees and will save approximately $60,000,000 annually. The combined savings effected by this action and that reducing maintenance-of-way employees' wages announced last week will, it is estimated, amount to about $110,000,000—nearly half of the loss of revenue expected to result from the recently-announced freight-rate reduction. The three labor members of the board dissented from the majority decision.

Public Service Is Keynote of A.A.E. Convention

(Engineering News-Record Staff Report)

Public service in politics, in education through publicity, and in the perfection of machinery, was the keynote of the eighth annual convention of the American Association of Engineers held June 5-7 in Salt Lake City, Utah. Compensation received little attention compared with the foregoing considerations. An extended employment service, however, was authorized.

The newly elected officers are: President, A. N. Johnson; vice-presidents, G. E. Taylor and A. M. Knowles; directors, District 3, B. W. Matteson; District 8, W. S. Boyle; District 9, W. M. Peyton; District 11, C. A. Poole; District 12, F. C. Shepherd. Of the 11,451 qualified voters in the Association 47.6 per cent returned ballots, the same percentage as voted last year.

Shirley Becomes Chairman of Virginia Highway Commission

Governor Trinkle of Virginia has announced the appointment, effective July 1, of Henry G. Shirley as chairman of the new state highway commission created by the last session of the general assembly. Mr. Shirley is at present county engineer of Baltimore County, Maryland, and was formerly state highway engineer of Maryland. He is a native of West Virginia and a graduate of the Virginia Military Institute. His early engineering work was in the railway field where he served with the New York Central and the Baltimore & Ohio Railroads. During the Spanish war he enlisted in the Third Volunteer Regiment of Engineers at Jefferson Barracks, Missouri, and went with that unit to Tampa, where he was detached for special service.

Mr. Shirley became state highway engineer of Maryland in 1912, succeeding Major W. W. Crosby, and during his term of office the bulk of that state's road system was constructed. In 1917 and 1918 he represented the American Association of State Highway Officials on the Highway Transport Committee of the Council of National Defense and later became secretary of the Federal Highway Council, with headquarters in Washington, D. C. When that organization suspended its activities Mr. Shirley received the appointment as engineer of Baltimore County. Last fall he was selected by George C. Diehl, president of the American Automobile Association, as chairman of that organization's Good Roads Board.

Mr. Shirley for years has been a leading figure in the highway field and was the first president of the American Association of State Highway Officials. During the hearings on the Federal highway bill in 1921 Mr. Shirley contributed from his experience a large volume of testimony to the Senate and House committees on roads. In his new post as chairman of the Virginia State Highway Commission he will receive a salary of $12,500.

Canada Appropriates $90,170,000 for Government Railways

The Canadian Parliament has appropriated $90,170,000 for the government railways, the principal items being as follows:

$42,800,000 to the Canadian Northern System to meet operating deficits; to pay for property, materials and supplies; to meet interest and sinking funds, and maturing or matured loans; for construction and betterments and co-ordination of lines and facilities.

$25,750,000 to the Grand Trunk Ry. system for like purposes.

$15,900,000 to the Grand Trunk Pacific Ry. for like purposes.

$2,800,000 to be advanced for the purchase or repair of equipment for the Canadian Northern and Grand Trunk Pacific.

$2,700,000 for construction and betterments on the Intercolonial & Prince Edward Island Ry. and the National Transcontinental Ry.

$150,000 toward the acquisition of the Buctouche & Moncton Ry. and the Caraquet & Gulf Shore Ry. as branch lines for the Intercolonial.

An appropriation of $221,635 was voted for the Board of Railway Commissioners.

Plans Complete for Engineering Education Convention

Elaborate plans are being made by those who have the entertainment in charge for the annual convention of the Society for the Promotion of Engineering Education, to be held at the University of Illinois June 20-23. Particular attention in the convention discussions will be paid the study of English in engineering courses, physics, graduate work, committee reports and the broader aspects of engineering education.

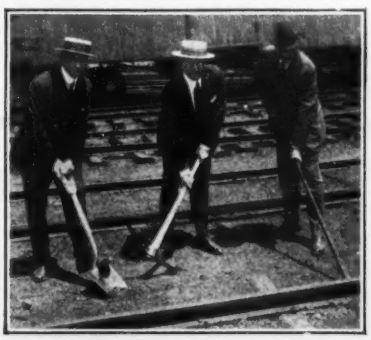
The annual dinner will be held June 21, and a smoker June 22. The College of Engineering will hold "open house." Trips to nearby engineering projects or other points of interest have also been provided.

Certificate in Public Health to Be Granted by M. I. T.

A certificate in public health, similar to that heretofore granted by the School of Public Health of Harvard University and the Massachusetts Institute of Technology jointly, will hereafter be granted by the Institute. Candidates for this M. I. T. certificate will be permitted to take courses in the School of Public Health of Harvard University, thus continuing the co-operation that has heretofore existed between Harvard and M. I. T. in this respect, although each institution will maintain an independent organization for public-health instruction.

Ground Broken at Jersey End of Hudson Vehicle Tunnel

Without formal ceremony ground was broken May 31 at the New Jersey end of the Hudson River vehicle tunnel, the 29½-ft. twin-tube project for which the contract was awarded to Booth & Flinn, L'td., New York City, at a cost of $19,331,723. The accompanying photographs were taken in the Erie R. R. yards in Jersey City at the site of the two land shafts for the tunnel. The action in starting work at the Jersey side comes after a long delay caused by controversy concerning the widening of Jersey City streets as part of the tunnel project.



Philadelphia Bridge Anchorage Contract Awarded

Bids received by the Delaware River Bridge Joint Commission for the anchorages on the Philadelphia and Camden sides on May 31 showed the following totals:

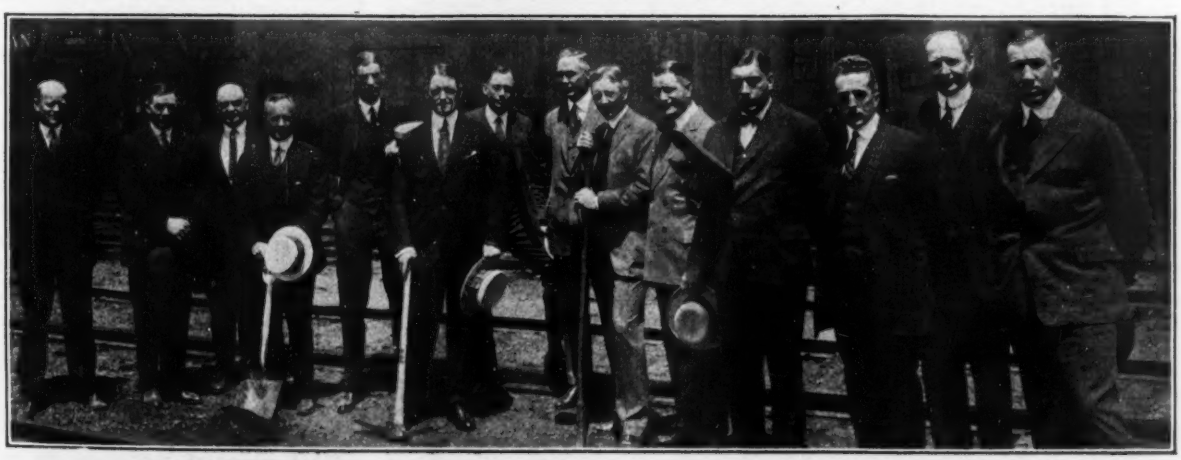
For the Philadelphia anchorage, Keystone State Construction Co. and Holbrook, Cabot & Rollins, Corp., $928,535; Frederick Snare Corp., $958,328; Arundel Corp. and Arthur McMullen Co., $964,983.60; H. P. Converse Co., $1,038,775; Underpinning & Foundation Co., and F. J. Boas, $1,183,868.60; Patrick McGovern, $1,276,917.50; Oscar Daniels Co., $1,352,625; Heyman & Goodman Co., $1,019,858.

For the Camden anchorage, Keystone State Construction Co. and Holbrook, Cabot & Rollins, Corp., $1,164,920; Frederick Snare Corp., $1,348,670; Arundel Corp. and Arthur McMullen Co., $1,327,876; H. P. Converse Co., $1,312,725.90; Underpinning & Foundation Co., and F. J. Boas, $1,644,661.70; Patrick McGovern, $1,528,885; Oscar Daniels Co., $1,766,655; Spencer, White & Prentis, $1,477,585.

Contracts were awarded on June 2 to the Keystone State Construction Co. and Holbrook, Cabot & Rollins Corp. for both anchorages. The major item in both contracts is for the caisson foundations, for which the successful bid on the Philadelphia anchorage asked $18.50 per cubic yard on a total property of 28,500 cu.yd., and the bid on the Camden anchorage, a price of $16.50 on a total of 27,000 cu.yd.

Atlanta Retains Old City Charter

At a second charter election, held May 30, the voters of Atlanta, Ga., decided to retain their present city charter, but with amendments, vesting the powers of existing water and other boards in the city council. A modified city-manager charter was defeated. The earlier charter election, with outlines of the three plans then voted upon, was noted in *Engineering News-Record*, May 25, p. 886.



BREAKING GROUND AT NEW JERSEY END OF HUDSON RIVER VEHICULAR TUNNEL

Upper picture: C. M. Holland, chief engineer; George H. Flinn, of Booth & Flinn, contractors; R. C. Falconer, chief engineer, Erie R. R.

Lower picture (left to right): 1. George Montgomery, tunnel superintendent, Booth & Flinn; 2. M. L. Quinn, general superintendent, Booth & Flinn (New York end) 3. M. I. Kilmer, resident engineer, Tunnel Commissions (New Jersey end); 4. C. M. Holland, chief engineer, Tunnel Commissions; 5. Le Roy Tallman, general superintendent, Booth & Flinn (New Jersey end); 6. George H. Flinn, secretary and treasurer, Booth & Flinn; 7. M. E. Chamberlain, chief engineer, Booth & Flinn; H. F. King, special engineer, Erie R.R.; R. C. Falconer, chief engineer, Erie R.R.; 10. W. A. Flinn, vice-chairman, Booth & Flinn; 11. J. C. Patterson, regional engineer, Erie R.R.; 12. F. J. Malloy, division engineer, Erie R.R.; 13. M. H. Freeman, engineer of construction, Tunnel Commissions; 14. R. H. Boykin, superintendent of terminals, Erie R.R.

Industrial Advertisers to Meet

The first annual Industrial Advertising Conference is to be held in connection with the eighteenth annual convention of the Associated Advertising Clubs of the World in Milwaukee, Wis., June 11-15. Those who have the program in charge emphasize the fact that it will be focused upon inter-industrial marketing and that this conference will present the first opportunity for this phase of selling and advertising to be given proper attention.

The chairman of the conference is Keith J. Evans of the Engineering Advertisers' Association, Chicago, and among the speakers and their subjects are the following:

"Advertising as a Factor in Inter-industrial Marketing," Max W. Babb, vice-president, Allis-Chalmers Mfg. Co., Milwaukee, Wis.; "What the U. S. Department of Commerce is Doing to Aid Inter-Industrial Marketing," F. M. Feiker, formerly Assistant to the Secretary of Commerce, Washington, D. C.; "Cutting the Costs of Distribution," Hon. Sydney Anderson, Congressman from Minnesota; "Advertising in its Relation to the Four Points of Contact in Industry," Bennett Chapple, Director of Publicity, American Rolling Mills, Middletown, Ohio; "Advertising the Technical Product to the Non-Technical Buyer," Charles H. Mackintosh, President of the A. A. C. of W. and sales and advertising counselor of the La-Salle Extension University; "Selling to the Professional Man in Industry," J. C. McQuiston, manager, Dept. of Publicity, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.; "Expanding the Markets for Raw Materials," H. Colin Campbell, manager of publicity bureau, Portland Cement Association, Chicago; "Putting Ideas into Industrial Advertising," W. Lee, vice-president of Frank D. Chase, Inc., Chicago; "The Outlook for Business in the Industrial Field," Edwin F. Gay, president of the New York *Evening Post*.

U. S. Supreme Court Holds Unions Suable for Strike Damages

In its decision on the Coronado Coal case the U. S. Supreme Court has held that under Sections 7 and 8 of the Sherman anti-trust law, labor unions are suable for damages caused by their strikes and that funds collected for strike purposes can be assessed to pay such damages.

Although in the case under consideration the decision of the court was favorable to the unions, this phase of the decision is regarded as a heavy blow to union labor, which has relied upon the immunity of unions, as entities, from prosecution or legal action, and upon the freedom of their funds from any liability for the payment of damages. In the case at bar the court says that there is nothing in the circumstances to indicate that the labor organizations had in mind interference with interstate commerce or competition when they entered into their unlawful combination to stop non-union operation of the mines. The verdict in the District Court against the unions on this ground was reversed and the case set back for further proceedings in conformity with the opinion of the Supreme Court.

The Engineer in Public Life

CHARLES H. SIMPSON

Elected to the state legislature of Tennessee in November, 1920, Charles H. Simpson, of Nashville, after graduation from Vanderbilt University, began his engineering work as an instructor in mechanics in that institution in 1906, where he served for ten years. He resigned in 1916 to enter the automobile industry and organized the Hippodrome Motor Co. of which he is now vice-president and general manager. In 1918 Mr. Simpson was elected a member of the Davidson County Highway Commission on which he is still serving. His legislative work has included bills for the licensing of engineers and architects, the creation of a state department of forestry, tax levy for a permanent fund for the University of Tennessee, and anti-theft automobile legislation. Mr. Simpson is 41 years old and is a member of the Nashville Chapter of the American Association of Engineers.

Traffic on Pittsburgh Test Road Resumed June 1

Traffic was resumed on the test highway at Pittsburgh, Cal., on June 1. As in the earlier tests, one day per week is reserved for special tests and two streams of trucks carrying 5-ton loads run in opposite directions continuously 8 hours per day for six days of each week. The tests on this road, described in *Engineering News-Record* Dec. 29, 1921, p. 1048, were interrupted for some time, and meanwhile destroyed portions of the pavement amounting to almost 50 per cent of the total area have been replaced with new concrete.

The state highway commission has supplied 26 trucks for the continuation of the tests and the Bureau of Public Roads 20. Another fifteen will be put on by the Bureau of Public Roads if it is found, after traffic is under way, that this number can be handled to advantage. The speed is 14 miles per hour and loads are limited to conform to the state law, i.e., a maximum of 700 lb. per in. width of tire.

Congress Approves Port Authority Plan for New York Harbor

The House and Senate have passed bills consenting to the execution of the comprehensive plan prepared by the Port of New York Authority and adopted by the legislatures of the States of New York and New Jersey. The details of this plan, which provide for extensive tunnels, bridges, terminals, and belt lines to handle traffic into and through the port of New York, were described in *Engineering News-Record*, Jan. 5, 1922, p. 26.

Twelve of 21 Municipal Bond Sales Sales at 4½ to 4.05 Yield

Of 21 municipal bond sales reported by the New York *Times* for the week ending May 26, 8 bear 4½ per cent interest or less and 12 were sold to yield at the rate stated, 7 of the 12 yielding from 4.25 to 4.05. Three of the issues bear 6 per cent coupons but were sold to yield from 5.375 to 4.90.

Seattle Will Resist Bascule Bridge Suit

(*Special Correspondence*)

Seattle has decided to resist vigorously the suit of the Strauss Bascule Bridge Co. for $350,000 for infringement of patents in the construction of three city bridges, Fremont, Ballard and University. The suit is expected to come to trial in the Federal District Court shortly, and to prepare for it the corporation counsel has asked that $20,000 be appropriated to enable the city engineer to gather evidence.

Approval Given Federal Part in Sesquicentennial

(*Washington Correspondence*)

Full approval of federal participation in the Philadelphia sesquicentennial celebration has been voted by the committee on industrial arts and expositions. It has reported with certain amendments the Darrow bill and recommends that it receive the prompt approval of the House.

The bill as amended specifies that Fairmount Park shall be the site of the exposition and that the form of federal participation is to be determined by the President.

Move To Reform Building Inspection in Cleveland

Agitation has been started by the General Contractors' Association of Cleveland for a reform in building-law administration that will put an end to persistent violations of the law and widespread shoddy building construction which are said to be current. Skimping of various kinds, through departure from the file plans is common. Speculative house building is a particular field of the evil conditions. Sound construction and contracting conditions are suffering, it is claimed, and because of this and the value to the public of sound building construction the present agitation for reform has been begun.

Several meetings have been held at which the existing evils were fully discussed, and the need for remedial action established. Those engaged in the movement up to the present are chiefly contractors who handle large operations, but a smaller working committee now being organized is to include architects and engineers and representatives of commercial and financial interests.

What means of getting at the evil building conditions are practicable remains to be determined, but it is believed that one of the best possibilities is a co-operative inspection bureau to supplement the municipal inspection and make it possible to detect and check all violations of building code provisions or departures from permit plans.

Would Extend Mississippi River Commission's Jurisdiction

Legislation now is before Congress providing for the extension of the jurisdiction of the Mississippi River Commission to St. Paul. The recent floods have emphasized the need for the Commission's having control over the entire river. It also is probable that the Commission's jurisdiction may be widened to include limited areas around Mississippi tributaries and outlets.

Bill Proposes Federal Concern To Operate Muscle Shoals

A bill seeking congressional authority for the establishment of the Federal Chemical Corp. to extend and operate facilities at Muscle Shoals for the manufacture of fertilizer and nitrates has been introduced into the Senate by Senator Norris and referred to the Committee on Agriculture and Forestry.

The Norris bill proposes the leasing from the government of all its rights in and near Muscle Shoals or any property or rights which may come under government control in consideration of which the lessee is to carry out an extensive construction program for the development of power on the Tennessee River, the maintenance of navigation, the extension of the facilities at Muscle Shoals for the manufacturing of nitrates and refitting present facilities for the manufacture of fertilizers, etc. The projects specifically mentioned to be executed by the lessee are (1) Construction of Dam 1 or a channel for navigation from the railroad bridge below Muscle Shoals to the locks at Dam No. 2; (2) completion and equipping of Dam No. 2 ready to generate in conjunction with Dam No. 3 not less than 600,000 hp.; (3) the construction of Dam No. 3; (4) construction of locks or lifts to maintain navigation over the dams; and (5) the reconstruction and extension of the present nitrate plants. The estimated cost of these various projects is $60,000,000.

Construction work authorized by the Norris act is to commence within sixty days after the property located at Muscle Shoals is acquired. Within two years the hydro-electric plant is to be equipped and ready to generate 100,000 hp., in three years 200,000 hp. and within five years 600,000 hp. The construction is to be completed within five years.

The financial obligations of the company are to be met by receipts from the sale of power and the products of the nitrate plant. Fertilizer compounds produced by the plant are to be sold at a price and upon terms to be fixed by government directors.

The Federal Chemical Corp. is to hold its lease for 50 years. Business of the corporation is to be conducted by a board of seven directors. One each of these is to be selected by the Secretaries of War, the Treasury and Agriculture. The other four are to be elected by stockholders. The capital stock of the corporation is to be $5,000,000 divided into 50,000 shares of a par value of $100 a share. All of this is to be subscribed before any execution of a lease and at least $1,000,000 is to be paid in within 30 days thereafter. The board is required to make a report to Congress at the end of each calendar year upon the activities of the lessee.

Concreting of Hetch Hetchy Dam Progresses

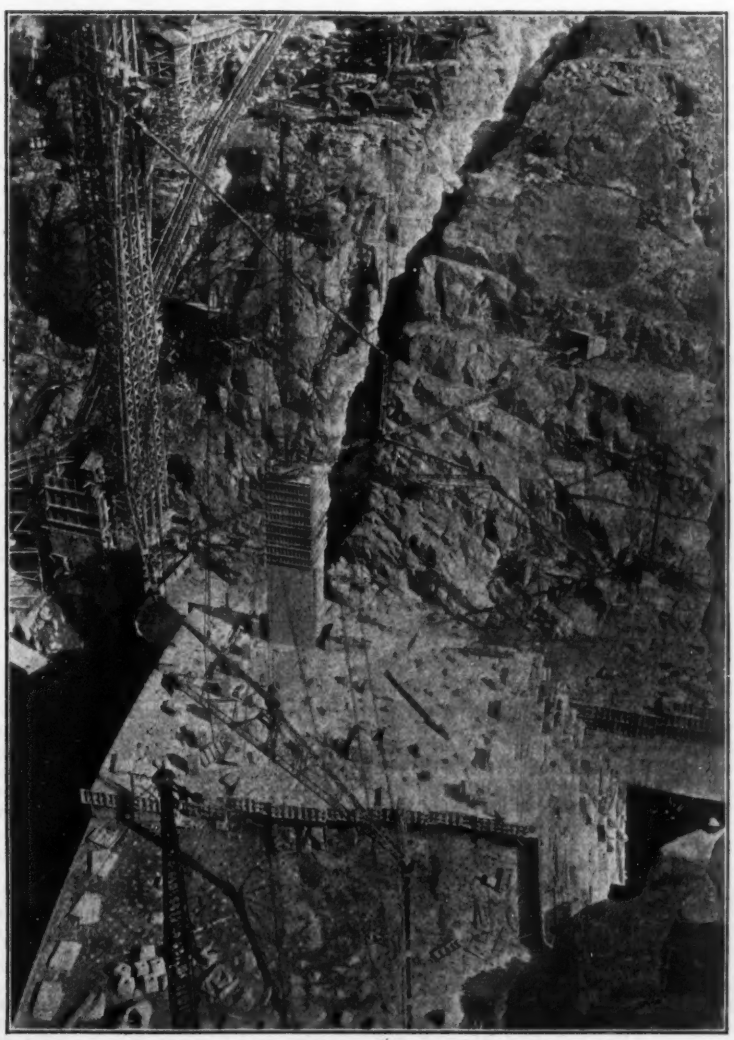
The pouring of concrete in the Hetch Hetchy Dam was resumed on April 21 after about a month's inactivity due to failure of the power supply. Since then work has been proceeding rapidly, about 1,500 cu.yd. per day of two eight-hour shifts being the usual run, although as much as 1,950 cu.yd. per day has been poured.

The concrete pedestal on which the derrick stands some 60 ft. above the adjoining concrete surface, as shown in the picture, was built up by a small force working with the limited power available while the main power supply was interrupted. In this way delay incidental to raising the derrick as the work advanced was avoided.

The wooden tower from which the concrete is chuted has four compartments and is 350 ft. high. Two compartments are served by each of the two 2-cu.yd. mixers. The mix is 1:3:6 and plums as large as can be handled by skips are used.

A horizontal section of the dam at its present height of 168 ft. includes an area of 450,000 sq.ft. which is greater than the area in any other horizontal section of the structure, hence the amount by which a given yardage of concrete increases the height is now the least. The overall height under the present contract will be 344 ft. An article on the foundation excavation for the Hetch Hetchy dam appeared in *Engineering News-Record* Aug. 11, 1921, p. 222.

About 150,000 cu.yd. had been placed in the dam by May 1, leaving 220,000 cu.yd. yet to be poured under the present contract.



LOOKING DOWN ON THE DAM FROM THE NORTH BANK

Note the plums. Structure is here shown 68 ft. above lowest concrete. A row of porous concrete drainage wells begins just upstream from the pedestal. Cut-off trench in background.

Protest Against Law Requiring Ten Years' Liability

A committee has been formed of representatives of the Corporation of Engineers, Association of Architects and the Building Exchange, Montreal, Can., to take up the question of having repealed or amended the clause of the civil code which holds the building contractor and the architect jointly responsible for any structure built by them for a period of ten years from completion of the building.

Chicago Small Building Situation and the Landis Award

A boom in the construction of small dwellings and flats in Chicago is shown by a statement of the Citizens Committee to Enforce the Landis Award, a block-to-block survey giving 1,473 single-family houses and 769 two-flat buildings under way on May 1. It is estimated that over 7,000 structures of these two classes will be completed in 1922, representing about $70,000,000. These figures are exclusive of the larger apartment buildings (for which several thousand permits have been issued) and also of the buildings in suburban towns within easy transportation distance of the business district. Under these conditions a marked drop in rents is expected. Up to May 26 the Citizens Committee had brought into the city about 11,832 open-shop craftsmen to work in the trades whose unions have refused to accept the Landis Award. New building work brought the Landis Award jobs under construction to a total of $55,000,000.

Columbus Water-Works Dam Contract Again Awarded

The re-advertisement of the contract for the O'Shaughnessy dam for the water-works of Columbus, Ohio, which brought seven bids on May 25, resulted in the award of the contract to the Thompson-Starrett Co., New York City, for $1,165,511, the lowest bid. All but one of the new bids was below the engineers' estimate of $1,376,700. The bids other than the successful one were: Hickey Brothers, Columbus, Ohio, $1,195,846; John F. Casey Co., Pittsburgh, Pa., $1,211,136; Lake Erie Construction Co., Cleveland, Ohio, $1,243,000; E. H. Latham Co., Columbus, Ohio, $1,325,733; H. P. Converse & Co., Boston, Mass., $1,350,285; Dravo Construction Co., Pittsburgh, Pa., $1,434,955.

The engineers' estimate was originally $1,375,300 and the three corresponding lowest bids on April 20 were: Columbus Construction Co., $1,001,616; Thompson-Starrett Co., $1,115,119 (or $50,392 lower than its winning bid after re-advertisement); J. F. Casey Co., $1,173,257. (For corresponding unit prices, see Construction News Section of *Engineering News-Record*, May 18, page 255.)

The Columbus Construction Co. refused to execute the contract awarded to it under its bid of April 20 because of alleged errors totaling $73,500 and afterwards secured an order from the county court for the return of the certified check accompanying its bid (see *Engineering News-Record*, May 18 and 25, pp. 845 and 879).

C. B. Hoover is engineer in charge of the Columbus Bureau of Water Works Extension, and Prof. John H. Gregory, Baltimore, Md., is consulting engineer.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; Annual Convention, Portsmouth, N. H., June 21-22.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, University of Pittsburgh; Annual Convention, University of Illinois, June 20-23.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; Annual Meeting, Atlantic City, N. J., June 26-30.

NEW ENGLAND WATER WORKS ASSOCIATION, Boston; Annual Convention, New Bedford, Mass., Sept. 12-15.

The Western Society of Engineers held its annual dinner on June 7, at which time the new officers were presented. The principal speaker was Dr. R. C. Richards, until recently with the college of engineering at the University of Illinois but now president of Lehigh University.

The Engineers' Club of Baltimore, at the annual meeting on June 1 elected the following officers: President, Douglass Barnett; first vice-president, Frank M. Bowles; second vice-president, G. J. Requardt; treasurer, Henry Adams; directors-at-large, A. G. Decker, Adrian Hughes and A. L. Penniman.

The Engineers Club, Seattle, recently entertained Col. W. G. Atwood, director of the committee on marine piling investigations of the National Research Council, who delivered an illustrated address on "The Teredo and Other Marine Borers." Col. Atwood intends to further the organization of a committee in Seattle to carry on investigations in Puget Sound waters, co-ordinating these efforts with similar investigations being conducted in New York, Boston, San Francisco and the Gulf ports.

Personal Notes

H. RALPH HADLOW and NOEL H. HICK have formed an engineering partnership with offices in Cleveland, Ohio. They will specialize in the design, supervision and construction of industrial and commercial buildings. Mr. Hick was formerly engineer in charge of building and Mr. Hadlow vice-president and general manager for the Watson Engineering Co., Cleveland, Ohio.

E. L. MARTIN, engineer of maintenance-of-way for the Missouri, Kansas & Texas Ry., has resigned that position and has purchased an interest in the Hutt Contracting Co. of Kansas City, Mo. His resignation was effective June 1. Mr. Martin is vice-president of the contracting company. For 23 years he has been identified with several railroads in the Southwest on important engineering projects.

WILLIAM J. KNAUER, county engineer of Chautauqua County, N. Y., with offices in Jamestown, has resigned and will engage in contracting work with his own organization.

G. H. STANCHFIELD has been made city engineer of Fond du Lac, Wis. He succeeds R. B. PETTERS who recently resigned.

F. H. ROOD, formerly assistant engineer of tests of the Pittsburgh Testing Laboratories has resigned to do highway research for the Advisory Board on Highway Research of the National Research Council. Mr. Rood will be stationed at Harrisburg, Pa.

H. G. DIMSDALE, engineer of the Lacombe Northwestern Ry., has been appointed highways commissioner of the province of Alberta, Can., under the new Public Highways Act.

HAL M. SCOTT and JOHN P. BONNER have opened an office in Beckley, W. Va., for the practice of civil and mining engineering.

H. O. BAGLEY has been made field engineer for the Scott Brothers Construction Co., Rome, N. Y., the contractors in charge of the reconstruction of the Erie Canal, Rochester, N. Y., to fit it for rapid-transit purposes.

ROSCOE K. EARLE, former city engineer of Davenport, Iowa, has opened offices in that city for the practice of general civil and sanitary engineering. He will specialize in town planning, sewerage, sewage disposal, water supply, flood relief, drainage, paving, surveying, and subdivision work.

R. D. ORDERS, who has been bridge inspector for the Department of State Roads and Highways of Kentucky for severeal years past, recently resigned and is now connected with the Speed-Parker Co., general contractors of Louisville. Mr. Orders will be in charge of the construction of the Gulf Beach Highway in Florida, a project costing approximately $450,000.

DR. TOBIAS DANTZIG, former instructor of mathematics in Columbia and Johns Hopkins Universities and until recently research engineer of SKF Industries, Inc., New York City, has resigned to engage in scientific and technical consulting work. He will specialize in bearing problems and mathematical research of an engineering character.

JOHN B. HUNTER, city engineer of Denver, Col., has resigned after forty-three years of continuous service in the city's engineering department. He began as a chainman on a surveying crew and became city engineer in 1891. Ill health was the cause of his decision to retire. In recognition of his long service, the city has made him consulting engineer at a salary of $1,200 a year. A. K. VICKERY, superintendent of parks, has been appointed his successor and the duties of the two offices will be combined. Mr. Vickery's engineering experience includes service with the Colorado & Southern and Colorado Midland Railroads and the Colorado Fuel & Iron Co.

BUSINESS NOTES

COL. H. M. BUSH has been named district representative in the Columbus district for the Illinois Engineering Co. He will have offices in Columbus, Ohio. Col. Bush also represents the Steel Fabrication Corp.

HARVEY L. MILLER who has been district sales agent in St. Louis for the Youngstown Sheet & Tube Co., Youngstown, Ohio, since 1914, has become associated with the Jones & Laughlin Steel Co., of Pittsburgh, as St. Louis district sales agent.

H. E. MARKS, INC., Pittsburgh, Pa., a firm specializing in reinforced-gypsum roof and floor construction materials, has opened a district sales office in Cleveland, Ohio. A. W. KREAMER, formerly of the Dravo Contracting Co., is in charge of the new office.

EDWARD P. PALMER, who recently became associated with the Arthur McMullen Co., New York City contractors, has been elected secretary of the company. Mr. Palmer was with the Pennsylvania R.R. for some time and later was superintendent for the Rapid Transit Subway Construction Co., New York City, on that company's Seventh Avenue subway contracts.

H. L. SCHWARTZ, formerly of Schwartz & Pease, Philadelphia, has opened an office in the Franklin Trust Bldg., that city, where he will continue to represent the American Well Works of Aurora, Ill., and the Dean Brothers Steam Pump Works of Indianapolis, Ind.

OBITUARY

OBED J. PEASE, general contractor, of Long Beach, Cal., died there recently. Mr. Pease formerly lived in Wichita, Kansas, but moved to Long Beach about eight years ago, where he became one of the important contractors in lower California.

DAVID M. KIDDER of East Weymouth, Mass., a constructing engineer and of late years connected with the Boston Bridge Works, Inc., East Cambridge, Mass., died recently at the age of 76 years.

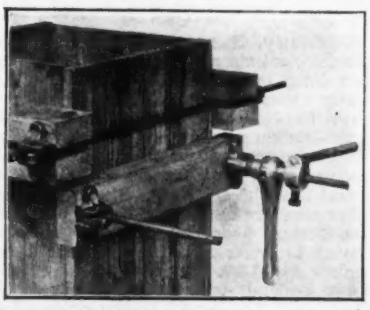
ARTHUR S. MORRIS, auditor of capital expenditures of the Chicago & Northwestern Ry., died May 22 at his home in Oak Park, Ill. He was born at Chicago in 1880 and after graduating from Princeton University in 1903 he entered the engineering department of the Chicago & Northwestern Ry., becoming assistant engineer in 1910. In 1918 he was appointed engineering auditor and in 1920 was made auditor of capital expenditures. Mr. Morris was second vice-president of the American Association of Engineers and a member of the Western Society of Engineers.

WILLIAM C. EDES, former chief engineer of the Alaska Engineering Commission and for many years associated with the Southern Pacific Co. in construction work in Oregon and California, died recently in Merced, Cal. Mr. Edes was 66 years of age. During the early part of his professional career Mr. Edes was associated with the Southern Pacific Co. on locations through Arizona, New Mexico and Texas. Later he engaged in general engineering work in Boston and vicinity with M. M. Tidd, acting as assistant engineer in charge of constructing water works at Weymouth, Mass., among his other duties. He then became assistant engineer in charge of constructing a portion of the Oregon and California R. R. for the Southern Pacific Co. and as engineer on construction of various branch lines. In 1895 he was made principal assistant engineer of the San Francisco and San Joaquin Valley Ry., a position he held for several years. He was appointed a member of the Alaska Railway Commission in 1914, resigning his position as chief engineer of the Northwestern Pacific R. R. During his professional career he was associated with John F. Stevens, then with the Great Northern Railway and with William Hood, former chief engineer of the Southern Pacific Co.

EQUIPMENT AND MATERIALS

A New Form Clamp

To hold the ends of rods clamping concrete forms together a rod-gripping clamp has been devised which has teeth on a cam making the clamp self-locking by a tap of a hammer on the cam. The forms are cinched up by means of a

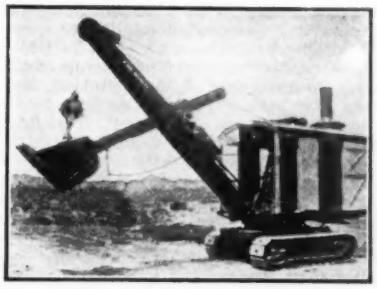


ratchet tightener which slips over the rods against the clamp and is secured in place on the rod by a lever-handled cam grip. The form clamp and tightener are made by the Victor L. Phillips Co., Kansas City, Mo.

Strengthened 20-Ton Steam Shovel

A general strengthening of the older patterns has been undertaken in the design for the new 20-ton shovel of the Erie Steam Shovel Co., Erie, Pa. The new machine has hoisting power enough to handle a full size ¾-cu.yd. dipper (water measure) even with a 21-ft. boom and 18 ft. 6-in. dipper handle.

Improvements in the trucks include a reinforced truck-frame, a propelling shaft with ample strength to stand the severe abuse that this shaft sometimes receives on a caterpillar-type machine in cold weather when the treads have been frozen in; and split collars on the rear axle, for throwing the propelling gears on a traction-wheel shovel out of mesh so that the shovel can be towed behind a motor truck. The new turntable casting has flanged webs for greater strength and has guards to keep water off the cone-roller path so that this path remains absolutely dry and the rollers do not slide. A new boom hoist provides instant accessibil-



ity for the hoisting engine crank-shaft bearing. The hoisting engine crank shaft is heavier. There is also a new 3-feed oil pump for positive lubrication of the hoisting, swinging, and crowding engines.

Another improvement is the new design of the main swinging shaft bearing, by which the bushings can be renewed in a few moments, by the insertion of interchangeable bushings of a special bronze. Smoother operation has been assured by machine-cut gears on the hoisting, swinging and crowding trains. Even the bevel gear and pinion at the beginning of the swinging train is machine-cut instead of cast.

To provide still greater strength in hard digging, the supporting lugs are placed outside of the boom, so as to compact instead of spread the boom members when the boom is subjected to twisting strains. Another entirely new feature is the automatic tripping device—a drum which turns with the dipper-shaft and keeps the trip rope taut, automatically winding and unwinding the trip rope as the dipper handle is moved in or out.

The dipper is provided with a double-hinged latch lever; a lever which moves freely from side to side and does not bend if it strikes a car or wagon, nor can it break wagon boxes nor car sides. Accordingly no time is ever lost by the operator having to straighten this latch lever, and there is no expense for repairing wagons and cars. The dipper itself has been strengthened by a heavier lip, and also stronger hinges.

The particular improvement at the power-producing end of the new machine is a larger boiler, with steaming capacity up to the full limit of speediest shovel operation. To economize fuel, the shovel is equipped with an auxiliary exhaust—a new feature which permits exhausting to the rear of the shovel instead of through the stack at times when the large boiler is providing ample steam and induced draft is not required.

Business Side of Construction

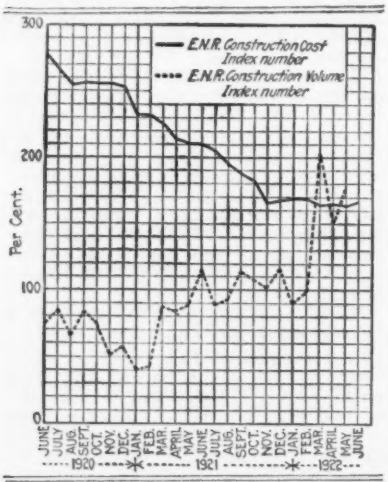
Facts and Events that Affect Cost and Volume

Construction Cost Is Likely To Advance

Engineering News-Record's Index Numbers Show Reason—Analysis of Past and Coming Demands and Prices

Since June, 1920, the construction cost curve has declined steadily. The heaviest drops from one month to the next were during January, 1920, and October, 1921. The latter drop—16 points or 9 per cent, according to *Engineering News-Record's* Cost Index Number, pictures the final slump of the steel market and labor deflation, and was the last important decline to be recorded. Since then cost has been about the same from month to month, even creeping up slightly.

Prices are stiffer, and there is a growing feeling that they may rise generally. Warrant for this feeling may be found in a study of the accompanying chart, in which the *Construction Cost Index* (CC) and the *Construction Volume Index* (CV) are plotted to the same scale. The C V Index shows the rate at which contracts are being awarded compared


E.N.R. Construction Cost Index number
E.N.R. Construction Volume Index number
Per Cent.
300
200
100
0
JUNE JULY AUG. SEPT. OCT. NOV. DEC. JAN. FEB. MAR. APRIL MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC. JAN. FEB. MAR. APRIL MAY JUNE
1920
1921
1922

with 1913 activity. From June, 1920, to June, 1921, the average monthly rate (70 per cent) was 30 per cent lower than in the year before the war—and 1913 itself was a subnormal construction year. On the other hand the average rate for the last twelve months has been 122 per cent, which is 22 points greater than for 1913 and 74 per cent higher than for the preceding twelve months.

Confidence began to return to the construction industry with the opening of 1921. This is clearly reflected in the jump of the C V Index from 43 to 88. By May the 100 per cent level had been reached, activity being equal to the average 1913 rate. This general level was maintained during the rest of the year. Only minor ups and downs of the curve appear during this period.

The abrupt increase in contracts let in February, 1921, followed by a continuance of this higher volume rate, began to show visible effect in November, 1921—ten months after the first impetus. Construction cost climbed slightly. It settled back during February, 1922, but the rise was resumed in March, and the advance since then has amounted to about 4½ points, or nearly 3 per cent.

It is plain that the second great impetus of the last two years—beginning with 1922—has not yet had anything like its full effect upon prices of construction materials. It is not likely that the experience of the first impetus will be repeated in the second instance, and that ten months will pass before prices react to promised increased demand. There was a reason for this ten-month period in 1921. It would have been a difficult feat to have stemmed the 1920-1921 decline in cost, even if anyone had wanted to do so. Prices had to come down, and only a practically impossible call for materials and labor could have kept them up.

Therefore, even with the increasing prospective demand for materials, prices and labor rates continued to decline until balanced by actual ordering of materials for the new construction. As stated, this steadying took place beginning November last.

The construction impetus initiated last January by the final price drop is already beginning to stiffen prices and labor rates. Steel and cement are firm. Brick, on the other hand, is jumping upward in a most unhealthy manner. Lumber is rising generally. The average rate paid common construction labor is slightly higher than a month ago.

Obviously, then, construction cost is due for an increase; how much and for how long cannot be predicted. It is easily conceivable that steel—the material hardest hit in the slide from the peak—may return to $1.75 per 100 lb. for structural shapes. Last fall the feeling was quite general that this would have been a workable price. As there was practically no actual demand for steel at the time, the market continued to weaken until steel could be bought at $1.30. Future prices of cement depend largely upon the coal situation. Adding $2 to the price of a ton of coal at the mines increases the cost of cement 20c. per bbl. One such advance, in the East, was announced in the May 18 issue. Prices elsewhere are generally steady. Brick prices are already out of reason, but with continued demand and insufficient production there is nothing to prevent still greater inflation.

What will be this increase in construction cost? A guess that would be as good as the next would be five per cent (an Index Number of 175).

Professor Irving Fisher writes: "In reply to yours of June 2 I would say that I think the 'new normal' is a delusion and a snare." His excellent letter will be published here next week.

Revised Building Materials Index of Labor Bureau

The Bureau of Labor Statistics recently made a radical revision of its Building Materials Index Number. Revision of the data regarding lumber is largely responsible for lowering the index number for April from 203 on the old basis to 152 on the new basis. The Bureau offers this explanation:

"The index numbers hitherto published by the Bureau have been influenced to a large extent by lumber prices in the New York market. These were practically the only prices available to the Bureau at the inception of its series of weighted index numbers in 1913. It has recently become possible, however, to substitute lumber prices in other and more representative localities for those previously obtained in the New York market. In all such cases the new prices have been carried back to 1913."

"In addition to the changes with respect to lumber, structural steel and a number of other important building materials not previously included in the index have been introduced into the revised index number and carried back to 1913. A comparison of the articles in the old and new index numbers is as follows:"

"Old series—Brick, Chicago; brick, Cincinnati; brick, New York; portland cement, mill; plate glass (2 series), New York; window glass (2 series), works; spruce lath, New York; lime, plant; Douglas fir (2 series), mills; hemlock, New York; maple, New York; plain white oak, New York; quartered oak, New York; white pine, New York; yellow pine flooring, New York; North Carolina pine, Norfolk; poplar, New York; spruce, New York; white lead, New York; linseed oil, New York; turpentine, New York; zinc oxide, New York; putty, New York; rosin, New York; cypress shingles, mills; and red cedar shingles, mills—total, 29 price series."

"New series—(a) Lumber: Douglas fir (2 series), mills; gum, St. Louis; hemlock, Chicago; maple, Chicago; plain white oak, Cincinnati; white pine, Buffalo; southern yellow pine flooring, mills; southern yellow pine timbers, mills; poplar, Cincinnati; spruce, Boston; yellow pine lath, mills; cypress shingles, mills; and red cedar shingles, mills; (b) Brick, average of 82 yard prices; (c) Structural steel, Pittsburgh; (d) Portland cement, average of 6 plant prices; crushed stone, New York; gravel, average of 22 plant prices; hollow tile, Chicago; lime, average of 15 plant prices; sand, average of 26 plant prices; slate, quarry; plate glass (2 series), New York; window glass (2 series), works; linseed oil, New York; putty, New York; rosin, New York; turpentine, New York; white lead, New York; zinc oxide, New York; cast iron pipe, New York; sheet copper, New York; copper wire, mill; lead pipe, New York; wire nails, Pittsburgh; reinforcing bars, Pittsburgh; roofing tin, Pittsburgh; and sheet zinc, mill—total, 41 price series."

"Besides the substitution of lumber prices in other localities in place of the New York city prices and the inclusion of a number of new articles in the revised index, the figures have been further revised by the use of the more recent 1919 census data for weighting purposes instead of the 1909 data formerly employed. In the case of lumber, particularly, the use of the more recent information has appreciably affected the index numbers, since the cut of most kinds of lumber was much smaller in 1919 than in 1909."

It should be understood that revision of the Labor Department's building materials index number in no way affects the *Engineering News-Record* Construction Cost Index Number, which is computed exclusively from original sources of price data.

Production and Materials Stocks In Ten Cities

Steel Output Increases—Lumber and Sewer Pipe Stocks Lower—Brick Shortage Extends

Steel—Production of steel ingots proceeds at 70 to 75 per cent of capacity, which is the same as a month ago (73 per cent). Sheet mill operations are at 80 to 90 per cent at present, while fabricated steel output recently reached 98 per cent of capacity. The coal strike has had little effect upon steel production, current figures being slightly in excess of the output at the beginning of the strike. Steel ingots are being produced at the rate of about 38,000,000 gross tons a year, as against 35,000,000 for April and 30,000,000 for March. In proportion the foundries have not been nearly as active as the steel mills. Stocks of raw materials, at pig iron producing centers, are said to be slow.

Lumber—An average of 391 mills reporting weekly to the National Lumber Manufacturers' Association for the first three weeks in May, show 690,992,165 ft. cut, or a weekly average of 230,330,721 ft. b. m. as against 228,841,250 ft. per week during April. Latest available figures show lumber production at only 5 per cent below normal, while shipments stand at 5 per cent and orders 20 per cent above normal.

Cement—Production of portland cement in April, according to U. S. Government reports, totaled 9,243,000 bbl., an increase of nearly 40 per cent over March and 600,000 bbl. more than a year ago. Shipments also increased, but less rapidly than production, with the result that stocks rose 650,000 bbl., with a total of 14,498,000 bbl.

Brick—Reports from 99 members of the Common Brick Manufacturers' Association of America show more orders on the books than a month ago, nearly double the amount of brick produced in the last month as compared with the previous month, and a largely increased amount of shipping from the plants. In some few centers the reports show a shortage of labor and slight increase in fuel costs.

Detroit—Small stocks of asphalt, granite block and hollow tile; ample supplies of sewer pipes, lumber, common brick and lime. Dealers' stocks of sand and gravel heavy; moderate supply of crushed stone. No wood paving blocks on hand; deliveries require several days. Nearby mills producing cement at full capacity to meet present demands.

Minneapolis—Retail lumber stocks trifle below normal; wholesale stocks about as a month ago but mills in this section are oversold to about 25 per cent of normal. If production does not increase the mill situation will be reflected in the wholesale and retail trade in about 30 days. Supplies of other materials ample excepting sewer pipe in the smaller sizes, 12-in. and under. Demand for smaller sizes in excess of supply. Sewer pipe manufacturers reported out of Illinois and Indiana soft coal and to be buying eastern Kentucky and West Virginia coal at twice the price and five times the freight rate.

Seattle—Lumber business in Pacific Northwest and particularly in Puget Sound district experiencing prosperity not exceeded by any year since the close of the war. Weekly cuts, orders, sales and shipments of the past few weeks mark the high point since the signing of the armistice and lumbermen admit a "return to normal" in the industry. Stocks of practically all building materials in good shape with Eastern shipments coming through satisfactorily. Ample stocks of cast iron pipe and heavy stocks of steel bars and shapes but light demand.

Denver—Supply of brick entirely exhausted. Plants resuming work and ample supply will be available in about two weeks. Lumber dealers have plenty of open stock on hand but mill shipments are very uncertain.

Philadelphia—Coal situation affecting sewer pipe; supply decreasing. Asphalt demand active; sufficient quantity on hand. Cement, lime and wood paving blocks in great demand; stocks holding out. Sales of hollow building tile 100 per cent above last year and brickyards working at full capacity. Lumber demand heavy; supply running low.

New Orleans—No wood paving

CONDITIONS OF MATERIALS STOCKS IN IMPORTANT CENTERS

Stocks on hand in approximate figures, example: (cement, Denver, 10,000 bbl.); time required for delivery of carload lots to city job, example: (sewer pipe, Atlanta, 24 hr.); and stocks on hand in general terms, example: (common brick, New York, shortage.)

	Detroit	Minneapolis	Seattle	Denver	Philadelphia	New Orleans	Atlanta	Los Angeles	Chicago	New York
Sewer pipe	Plenty	Shortage, smaller sizes		Del. 24 hr., local plant	Coal strike may cause shortage		Del. 24 hr.	Large stock	Heavy	Sufficient Del. prompt.
Cement	Ample	Enough		10,000 bbl.	Sufficient		25 @ 35 cars	Fair	Ample	Enough; drawing on reserve.
Lime, common and hydrated	Regular shipments local plants	Sufficient			Fair; del. from kilns in 3 days		25 @ 30 cars	Enough	40 @ 50 cars	Plenty.
Common brick	Yards in city	Ample		Shortage	Shortage		Plenty	Prompt delivery	Yards nearing 100 per cent capacity	Shortage. Some new brick received.
Hollow tile	Del. take several days	Large			Plenty		3 @ 4 days delivery	Yards well stocked	Large	Nearby plants.
Lumber	Receipts exceed demands	Retail stocks trifle below normal	Mills operating two shifts	Mill shipments uncertain	Stocks running low	Mills behind orders; demand exceeds supply	Plenty pine	No pine or spruce	Sufficient	7@ 8 wk. from mill.
Asphalt	Small			10 cars	Ample, at present					Refineries near city.
Structural steel			Heavy				5 cars			Heavy.

Is Brick Importation Practicable?

Relative to the recent suggestion that brick be imported into New York in order to relieve the stringency and reduce the price, the latest Monthly Digest of the Common Brick Manufacturers' Association of America comments as follows:

"Talk about importing brick is as foolish as some of the other statements coming out of the New York situation, when the facts are known. Brick is selling at a lower price in the principal markets in America today than in any of the English markets. The average price of common brick in England today is $15 a thousand. The price of brick delivered on the job in Chicago is $12 a thousand. To the price of brick delivered in New York City always must be added the exorbitant transportation charge which now exists, plus a dealer's profit, and local delivery charge. New York is one of the very few markets in America which buys its common brick through a dealer. In almost every other large city brick is produced within a short haul of the city and sold directly by the manufacturer."

Why debits to individual accounts are superior to listing bank clearances, as indicating general business activity, will be set forth in a special article contributed by the Federal Reserve Bank of New York.

blocks on hand; manufactured when ordered. Lumber mills in this district away behind on orders for yellow pine; demand exceeding the mill output by about 24 per cent. The demand is confined chiefly to the Gulf and Atlantic coast states. Recent high water in the timber districts has curtailed lumber production to a considerable extent.

Atlanta—About 35 carloads of cement; 30 carloads of lime and 5 carloads of structural steel on hand. Plenty of other materials. Deliveries of hollow tile in 4 days; sewer pipe in 48 hr.; sand, gravel and crushed stone in 24 hr.

Los Angeles—Plenty of building materials to meet present demand; deliveries prompt. Not on the market for paving block, spruce and yellow pine lumber.

Chicago—No shortage of construction materials but lumber demand becoming extremely keen.

New York—New brick of this season's manufacture are now arriving in this market, the supplies of last year's burned brick having been exhausted. No shortage of other materials. There are over 2,000 carloads of coal on hand in or about the Metropolitan district, representing an increase of over 200 per cent above the quantity on hand two weeks ago.

Hoover Plans to Limit Coal Price

Coal operators controlling nearly 85 per cent of the output in the fields now producing have agreed to accept for the duration of the strike $3.50 a ton for run-of-mine coal as a maximum with differentials fixed according to the plan established by the war-time fuel administration. This step has been taken as the result of action by the Secretary of Commerce to prevent a runaway market following a shortage which is beginning to make itself felt. Secretary Hoover is trying also to effect an arrangement for the same purpose with the retail coal dealers.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of June 1; the next, on July 6.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb.	$2.58	$3.50	$4.00	$2.48	$2.76	$3.50	$3.10	$3.60	$3.75
Structural rivets, 100 lb.	3.50	4.25	5.50	3.10	3.90	4.45	4.50	3.75	6.50
Reinforcing bars, ¾ in. up, 100 lb.	2.48	3.50	3.50	2.38	2.66	3.52½	2.55	3.60	2.75
Steel pipe, black, 2½ to 6 in. lap, discount	61%	61.15%	45%	59½%	61.9-5%	44%	+49.1%	53%	30.00
Cast-iron pipe, 6 in. and over, ton	+48.80@49.80	−46.25	48.30	44.10	+50.50	+57.00	51.00	52.00	50.00
Concreting Material:									
Cement without bags, bbl.	2.40@2.50	−2.34	2.25	1.97	2.24	2.90	2.83	2.94	2.48
Gravel, ¾ in., cu.yd.	1.75	1.85	2.25	1.80	1.50	−1.75	2.25	−1.25	1.50
Sand, cu.yd.	1.00	1.15	2.25	1.80	1.00	−0.75	1.50	−1.25	1.25
Crushed stone, ¾ in., cu.yd.	1.75	1.90	2.73	1.60	2.25	3.50	2.25	3.00	−1.60
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	+49.00	38.00	34.50	+45.00	39.00	36.75	+27.00	+21.50	47.00
Lime, finishing, hydrated, ton	15.80@16.80	+22.50	25.00	18.00	29.00	24.00	22.00	24.00	21.00
Lime common, lump, per bbl.	2.75@3.18	+1.75	2.50	1.40	1.40	2.70	1.75	2.80	11.00
Common brick, delivered, 1,000.	23.50	+10.00	11.15	11.00	16@17	12.00	15.00	14.00	16.00
Hollow building tile, 4x12x12, per block	Not used	−.075	.115	−.0707	.082	.08	....	.12	.09
Hollow partition tile 4x12x12, per block	.1112	−.0707	.115	.0657	....	.08	.108	.11	.....
Linseed oil, raw, 5 bbl. lots, gal.	−.88	−.94	1.09	−.98	−1.00	1.18	1.04	.86	.97
Common Labor:									
Common labor, union, hour	.75	.35	.....	.80	.....	.50@.55	.56¼	.50@.60	.....
Common labor, non-union, hour	.44@.60	.20	.25	.72½	−.35@.50	.35@.50	.47½@.50	.....	.20@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or − signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent. Charge is 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed store quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.55 for Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered, in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir common.

Seattle quotes on Douglas fir instead of pine. Lump finishing lime per 180-lb. net. Hollow building tile delivered. Hydrated lime in paper sacks.

Montreal quotes on fir instead of pine. Sand, stone, gravel and lump lime per ton. Lime and tile are delivered; cement, sand, gravel and stone, on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 99.19 cents). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½-in., $30; 6-in., $110.

Changes Since Last Week

Pittsburgh mill price of structural shapes and bars firm at $1.60 per 100 lb., with quotations reaching 10c.@20c. higher in points farther west. No change in warehouse prices throughout the country; buyers evidently holding off in anticipation of freight rate cut, effective July 1. Wrought steel pipe advanced in San Francisco and cast-iron pipe up $2 per ton in New York, Minneapolis and Denver. Active demand for steel-pipe; rise in cast-iron pipe due to higher pig iron and scrap quotations.

Cement down 5c. per bbl. in Atlanta during last two weeks. Owing to improved handling facilities and larger volume of business, sand is quoted in Denver at 75c. as against $1.10 and gravel at $1.75 as compared with $2.50 per cu. yd., at pit. Sand and gravel both down 25c. in Seattle.

Long-leaf yellow pine, base sizes, up $1 in New York and $5 per M. ft. in Chicago. Douglas fir advanced $1 in San Francisco. Lime and brick prices climbing higher in Atlanta. Slight declines in hollow tile both in Atlanta and Chicago.

Linseed-oil declining throughout the country. Raw oil down 7c. in New York and 6c. per gal., 5 bbl. lots, in Chicago, Atlanta and Minneapolis.